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PHOTOGRAPHY
for FUN *and* MONEY

By A. FREDERICK COLLINS

PHOTOGRAPHY FOR FUN AND MONEY
MONEY-MAKING HOBBIES
WORKING WITH TOOLS FOR FUN AND PROFIT
COLLECTING STAMPS FOR FUN AND PROFIT
FUN WITH ELECTRICITY
HOW TO RIDE YOUR HOBBY
MAKING THINGS FOR FUN
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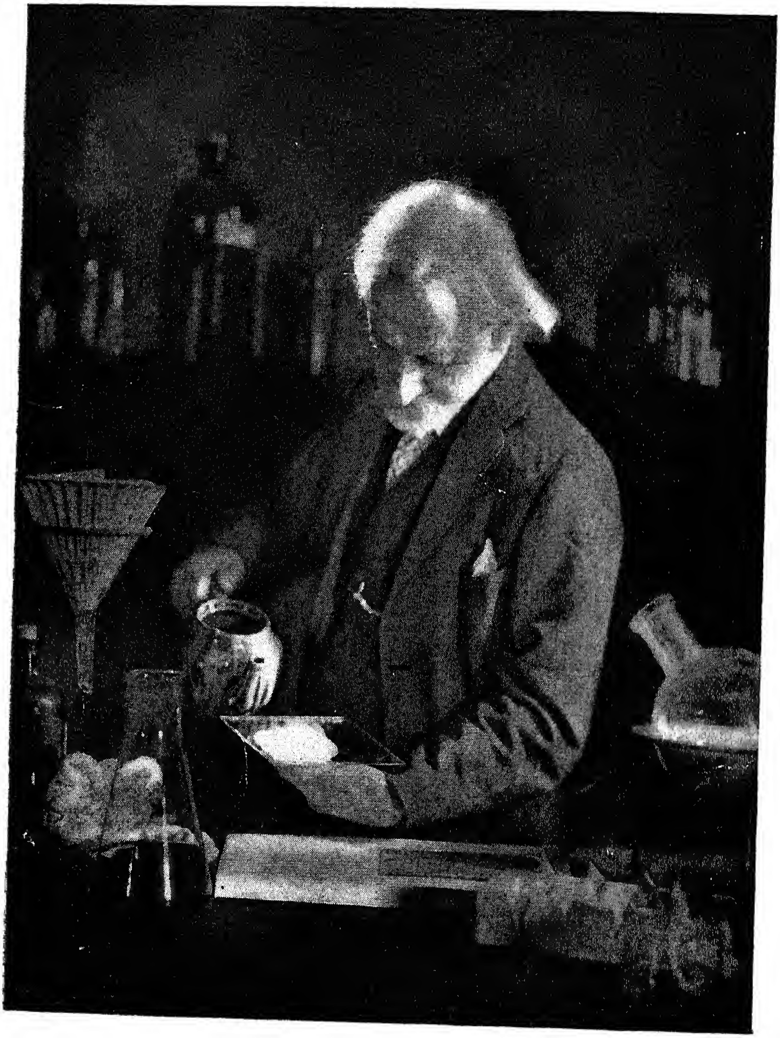

AN EARLY DRY-PLATE MAKER COATING A DRY PLATE BY HAND

PHOTOGRAPHY

For FUN *and* MONEY

By A. FREDERICK COLLINS

Fellow, Royal Astronomical Society

Past Member, Royal Photographic Society

D. APPLETON-CENTURY COMPANY

INCORPORATED

NEW YORK LONDON

1939

PRINTED IN THE UNITED STATES OF AMERICA

TO

MY BONNIE POET FRIEND,

MARGARET MARY MACINTOSH,

TORONTO and NEW YORK

A WORD TO YOU

Time reaps the years, yet now Photography
Defeats the Reaper! The magic key
Preserves the miracles of science, the arts,
Loved faces, and the treasures life imparts.
MARGARET M. MACINTOSH

THE march of photography during the last decade is almost beyond human credence, and this has come about chiefly through (*1*) the progress of science, (*2*) new pictorial concepts, (*3*) use of the miniature camera, (*4*) improved processes of color photography, and (*5*) advanced technique of moving-pictures.

In the realm of applied science the two outstanding factors that have given photography its tremendous impetus are (*1*) the anastigmat lens and (*2*) high-speed, fine-grain panchromatic plates and films. Science has also taken the guesswork out of photographic manipulations by the inventions of (*a*) the photoelectric exposure meter and (*b*) the time and temperature method of developing plates and films.

With the first named the veriest tyro can gauge the intensity of light and, it follows, the time of exposure, with unfailing accuracy, and with the second he can secure the precise degree of *gamma,* as the density and contrast of a negative are called, that he wants it to have.

The new pictorial concepts of the radicals, i.e., those who have broken away from the old conventional schools of art, were chiefly made possible, of course, by their own inherent ability to visualize and then to execute artistic, intriguing, and striking effects. This mental equation was greatly enhanced by (*a*) improved electric lighting and (*b*) new papers and better processes for making prints.

The æsthetic faculty which many possess to a high degree, but which very few can express through the natural coördination of

brain and eye and hand in putting their impressions on paper or canvas by means of brush and paint, can now be easily achieved by the magic of photography.

Comes then the miniature camera, small, as its name implies, compact and efficient, and fitted with a high-power lens, high-speed focal-plane shutter, light-exposure meter, range-finder, and moving-picture roll film. With it *action shots,* which include sports events, candid, and press pictures can be made in the thousandth of a split second and even under adverse lighting conditions.

The miniature camera is in high favor with photographic enthusiasts in all fields of endeavor, and it is preëminently suited to the needs of the amateur scientist who specializes in taking micrographs, astrographs, pictures of entomological specimens, and various other science studies. The better ones are provided with a battery of high-speed anastigmat lenses, each one of which is especially adapted for the individual work it has to do.

Color photography, as the making of pictures in natural color is called, proved to be an infinitely harder problem to solve than any of the other branches of the art for the very valid reason that there is no known way by which the various colors that form the image on the plate or film can be fixed by chemical action. But not to be defeated, inventive genius made a wide detour and devised ways and means for mechanically registering the colors instead of chemically fixing them. The end-product of these researches is photographs in color that can be made on paper, i.e., paper prints or on moving-picture film.

These color prints and projected pictures are beautiful beyond description, and so realistic they seem almost to stand out in three dimensions. If you have seen one or the other, you will agree that they portend the doom of the time-honored works of art that are so painstakingly put on paper and canvas with paint and brush.

It is obvious that oil- and water-color pictures are nearly as dated when compared with those that are made by color photography as the silhouettes of our forefathers when they are placed side by side with those that are painted. Yes, the pictures so carefully painted by hand, however great the artists, are, I fear

me, destined to the museum of antiquities, for more and more those who skilfully wield the brush are laying it down and taking up the camera in lieu of it.

Finally the art of taking and projecting moving-pictures is one of the greatest inventions that *Homo sapiens* ever made, for, as my young poet friend so aptly puts it, "Time reaps the years, yet now Photography defeats the Reaper"; this it does in very truth, for it brings a simulation of life to the screen which is at once so vivid and real that even those who have crossed the borderland seem again to be with us as they once were in the quick.

And now as a final word to you, let me say that if, by any chance, you are not one of the millions who snap pictures for the fun of it, then by all means hie you hither and get a camera—however cheap it may be does not much matter; but as you use it, give all due thought to the details of picture taking and making which are described in this book, and you will soon graduate into the class of the serious amateur.

Should your æsthetic faculty then manifest itself, it is your cue to invest in a really good lens and camera, and strive to express your ideals of form and beauty and perfection in terms of light and shade and color. In any event, of all the avocations which have given pleasure and surcease to the soul of man, none is more fascinating, cultural, and profitable than the art and science of photography.

A. Frederick Collins

Hollywood, California

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CHAPTER I

THE SAGA OF PHOTOGRAPHY

THE euphonious, but none the less scientific word *photography* (pronounced fo-*tog′*-ra-fe) was coined by combining the form *photo,* which we get from the Greek root *photos* meaning *light,* and the suffix *graph* from the Greek *graphos* which means *to write,* and, hence, the literal interpretation of it is *to write with light.*

Now, while the making of a photograph is not factually accomplished by writing it with light, it involves a great deal more than this implied simple process for it consists of producing and fixing the optical image by the chemical action of light, or by some other kind of radiant energy such as the infra-red rays, the ultraviolet rays and the X-rays, on a suitably sensitized plate, film, or paper.

The Evolution of the Photograph.—The action of light on various chemicals has been observed from time immemorial; thus Aristotle, the ancient Greek philosopher wrote away back there in the third century B.C., that the sun faded out nearly all of the colors then in use. From that time on until the middle ages nothing further was discovered that had a bearing *re* the action of light on chemicals, or *photo-chemistry* as it is now called.

Then in the sixteenth century came the alchemists—men of great imagination and little knowledge—who began an intensive but futile search for the *philosopher's stone,* a fancied substance which once compounded would, they believed, provide (*a*) an elixir that would cure all the ails the human flesh is heir to and so stave off old age, and (*b*) the means to transmute the baser metals into gold. In their mighty quest to find this priceless boon they made new salts and acids, and mixed and heated these with various metals and so unwittingly obtained newer and stranger chemicals, the real value of which they were totally unaware.

One of the salts they thus made was silver nitrate ($AgNO_3$), or *lunar caustic* as they called it, and this they did by dissolving silver (Ag) in nitric acid (HNO_3), and evaporating it when it took on the form of colorless crystals. Now when light rays fall on this salt, provided it is *in contact with organic* matter, such as paper, cloth, etc., it turns black. Other silver salts of the same class are silver chloride ($AgCl$), silver bromide ($AgBr$) and silver iodide (AgI), and all of these are quickly and powerfully acted on by the energy of light.

The first recorded observation that light so acted on these silver compounds was made by Johann Heinrich Schultz, a physician of Germany in *1721*. He had dissolved some silver in nitric acid and then mixed it with powdered chalk which contained some organic matter; when he exposed it to the action of light he found that it changed first to a brown color and then became black.

The next step was taken in *1771* by Carl William Scheel, a Swedish apothecary, who coated sheets of paper with silver nitrate and silver chloride solutions and found that the violet light of the spectrum formed by a beam of sunlight which passed through a prism, acted more quickly on the silver-coated paper than the light that formed the colors below it. He also rightly concluded that the reason the silver salts turned brown and black was because the light decomposed them and so separated out the metallic silver.

Some years later William Lewis, an English physician, repeated the experiments of Scheel, and after Lewis' death his papers fell into the hands of Thomas Wedgwood, the son of Josiah Wedgwood, the famous potter of England. With the knowledge of what Scheel and Lewis had done young Wedgwood went a step farther when, in *1802*, he actually made prints on paper coated with silver chloride by using paintings on sheets of glass for the negative.

Not only this but he tried to obtain images of objects on his silver paper with a camera, or *camera obscura* as it was then called. He failed in these attempts but Sir Humphrey Davy, of the Royal Institution, London, with whom he worked, succeeded in making a print on sensitized paper of the image of an object

which he projected on it by a solar microscope. These prints of Wedgwood and Davy soon faded out and so two fundamental problems of photography yet remained to be solved, and these were (*a*) to obtain an image on the paper with a camera, and (*b*) to *fix* them so that they would not be further acted on by light.

About the year of *1812* Joseph Nicephore Niepce (pronounced nē-eps), a French chemist, began to experiment with photography and in the course of the next few years he had worked out a very different process from the one used by Wedgwood and Davy. It consisted of coating a copper plate with a thin layer of asphaltum,[1] then placing a drawing made on transparent paper in contact with it and exposing it to the light of the sun.

Where the inked-in lines of the drawing prevented the light from acting on the asphaltum it remained soft, and where the light was free to act upon it it became hard. The soft asphaltum was washed out with a solvent until the surface of the metal plate could be seen, and he then applied nitric acid to it when it etched the lines into the plate. All of the asphaltum was then removed from the plate, when it was inked and printed from in the usual way. This was called the *heliogravure process,* and it was useful only for making printing plates.

About this time Niepce met Louis Daguerre (pronounced dä-gār), a French painter, and they worked together for many years. They made every effort to use the camera to form an image on the asphaltum plate, but as the latter was not nearly sensitive enough they were unable to do so.

In *1831* they began a new series of experiments and coated silver plates with silver salts; these they tried to use in the camera but still no images appeared upon them. Then in *1833* Niepce died and Daguerre carried on the work alone, but for the next four years the results were always the same—*nil.*

Finally, about *1837,* he exposed a silver plate to the vapor of iodine (*I*) when a thin film of silver iodine (*AgI*) was formed on it. He exposed it in his camera and although no visible image was

[1] *Asphaltum,* or *mineral pitch* as it is also called, is a brown to black solid mineral substance, and is probably formed as a residue by the evaporation of petroleum. It is soluble in turpentine, ether, alcohol, and chloroform.

to be seen on it he placed it in a cabinet overnight. In the morning he found, to his great surprise, that a visible image had appeared upon the plate. Searching for the cause he learned that the vapor of mercury (*Hg*), which he kept in the cabinet, had been deposited on the plate where the light had acted on it when it was exposed.

Further investigation proved that an exposure of only a minute or so in the camera was necessary to produce the latent image, and only a few minutes more was required for the mercuric vapor to bring it out and make it permanent. By *1839* Daguerre had brought his process down to a practical working basis, and this was the real beginning of photography. Photographic portrait studios were soon opened up in all of the cities and towns throughout the world and the *daguerreotype* process was the only one in use up to the middle of the nineteenth century.

While Niepce and Daguerre were experimenting with their silver metal plates in the early *1830's* William Henry Fox Talbot, of England, was working with the Wedgwood-Davy silver-paper process, and in *1839* he succeeded in taking a picture of the latticed window of Leacock Abbey. This he did by placing the sensitized paper while it was still wet in the camera and then exposing it.[2]

Fox Talbot used sodium chloride ($NaCl$), which is *common table salt*, to *fix* the image on the paper after it was exposed, but it is not a satisfactory agent for the purpose. In *1819* Sir John Herschel, an astronomer of England, discovered a chemical compound commonly called sodium hyposulphite ($Na_2S_2O_3$) which is *sodium thiosulphite*, or just *hypo* for short, as the photographers call it.

Sir John found, in *1839*, that hypo was the ideal *fixing agent*, and he imparted this information to Fox Talbot who thereafter used it instead of common salt. He termed the pictures he made *calotypes*, but Herschel devised a better name for them and called them *photographs*, and from this root we get the words *photographic*, *photography*, and *photographer*.

Now the pictures that Daguerre made in his camera on silver

[2] It is still preserved in the Science Museum at South Kensington, London, England.

plates were *positives,* and, it follows, each one had to be made separately, while those taken by Fox Talbot on silver paper were *negatives,* and from these he could make as many paper positives as he cared to. This is the reason that photography as we know it to-day is the offspring of Fox Talbot's *calotype process,* as he called it, and not that of Daguerre's *daguerreotype process.*

Fox Talbot made one other great contribution to photographic science and that was *developing* the negative to bring out the latent image on it, *i.e.,* so that it could be seen and was strong enough to make prints from. This important discovery very greatly reduced the time it had to be exposed in the camera. He used a solution of gallic acid[3] ($C_6H_2(OH_3).CO_2H$) to develop it with, and then came pyrogallol[4] ($C_6H_2(OH)_3$) (pronounced py-ro-*gal'*-lol), or, as it is commonly called, *pyrogallic acid,* and this was used for many years, and is still preferred by some photographers. Later on numerous other developers were discovered.

Since it was not possible to obtain a perfectly transparent paper to use for the negative Niepce de Saint-Victor (pronounced *nē*-eps de san vek-*tor'*), a French chemist and a nephew of Joseph Nicephore Niepce, in *1847,* coated glass plates with albumen (an organic compound) to which he added some potassium iodide (KI). The plates were then dried and when he wanted to make a negative he sensitized one of them by immersing it in a bath of silver nitrate, and then exposed it in the camera while it was still wet. This, then, was the beginning of the *wet-plate process.*

In *1838,* Théophile Jules Pelouze, a French chemist, invented *guncotton,* and this he made by immersing cotton in nitric acid (HNO_3), and then in sulphuric acid (H_2SO_4) and washing each of these out in turn when the cotton became an explosive. Then Christian Friedrich Schoenbein (pronounced *shen'*-bīn), a German chemist, found that by dissolving guncotton in a mixture of alcohol (C_2H_5OH), and ether ($(C_2H_5)_2O$) an organic viscous liquid resulted, and which he called *collodion.* Now while albumen,

[3] This is a white, crystalline acid that is found in the free state in galls, plants, etc., and it is also prepared synthetically.

[4] This is a derivative of gallic acid.

which Saint-Victor used to coat his glass plates with, formed a fragile and not very adhesive film on them, collodion formed a stronger film which firmly adhered to the surface of the plate.

Curiously enough it was not until *1851* that collodion was used as the base film for glass plates. In that year Scott Archer, of England, employed it for the first time and so produced the *collodion wet plate*. He added potassium (*K*) and iodine (*I*) to it, and when he wanted to take a picture he coated the glass plate with the mixture and then dipped it into a solution of silver nitrate; the iodine and the silver nitrate then reacted on each other and formed a silver iodide film on it. As soon as the plate was exposed he took it quickly to his darkroom, and then developed, fixed, washed, and dried it.

For the next quarter-of-a-century the collodion wet-plate process was used exclusively for making photographic negatives, but notwithstanding the hardships that beset the photographer by virtue of his having to coat the plates he used just before he exposed them and develop them immediately after he had exposed them, there were even then many amateurs and professionals who made out-of-door photography a hobby or a business.

Nearly all of these pioneers carried their whole equipment on their backs, as pictured in *Fig. 1*, and then when they wanted to take a picture they must needs set up the camera and darkroom, arrange the chemicals, sensitize the plates, and finally, take the picture as shown in *Fig. 2*, and believe you me, *they liked it.* Many remarkable photographs were made with these cumbrous outfits during the Civil War and some of the negatives are still in existence.

To overcome the difficulties attendant upon the use of the collodion-wet plate process J. Hill Norris, of England, coated them with gelatin after they were sensitized and then allowed them to dry. These were the first *dry plates* to be sold in the open market and while some very good negatives were made with them they were considerably slower than the wet plates. However, as they did away with the necessity of carrying around the heavy darkroom and equipment their advent marked the beginning of real amateur photography.

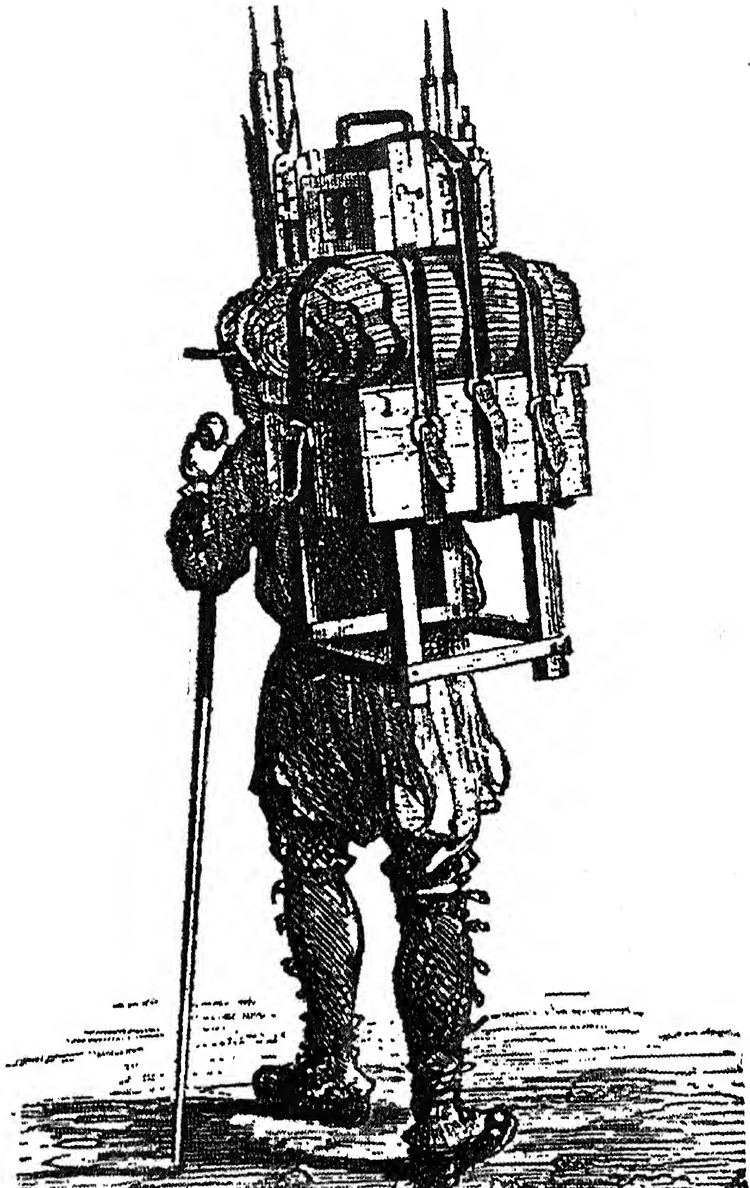


FIG. 1.—THE PORTABLE EQUIPMENT OF THE EARLY PHOTOGRAPHERS

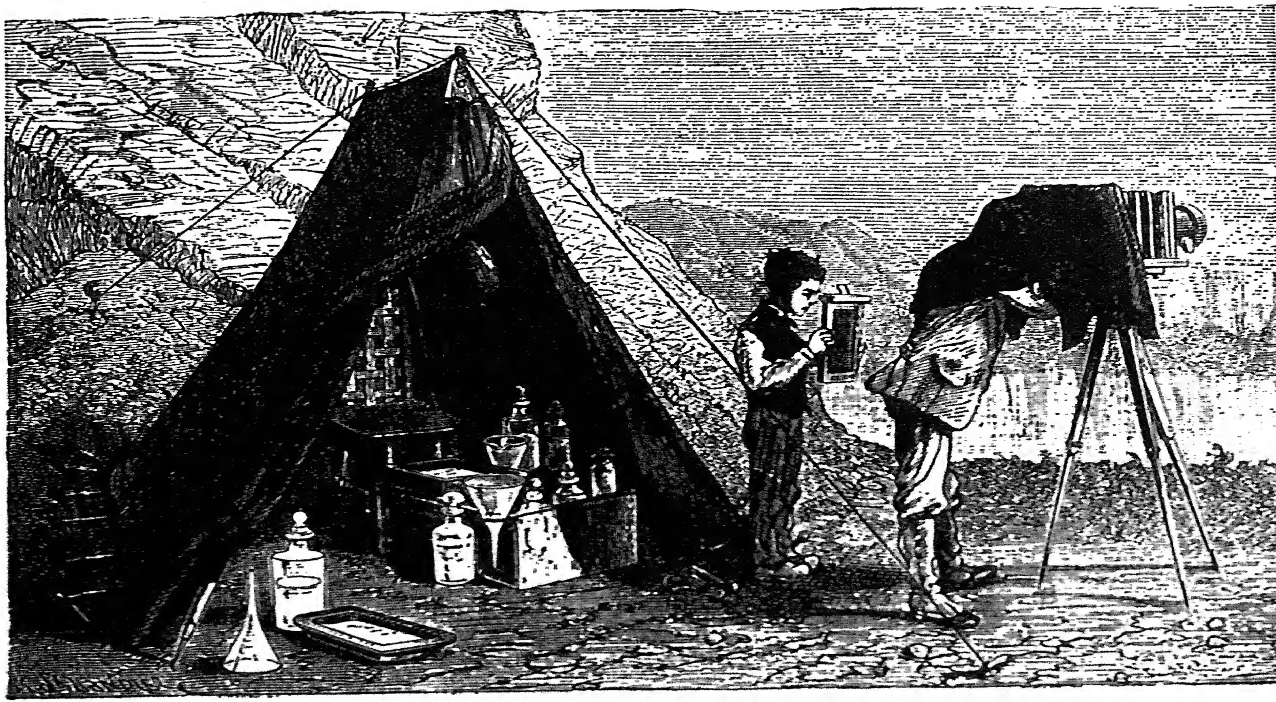


Fig. 2.—The Outdoor Photographer in the Good Old Days

(He had to sensitize his own plates in a portable darkroom.)

In *1864* Sayce and Bolton, of England, made a collodion dry plate that was considerably faster than that made by Hill and, it follows, it became quite popular. It was, however, slower than the wet plate so the latter was still used for indoor work.

The First Gelatin Dry Plate.—To overcome this untoward feature Dr. R. L. Maddox, of England, produced, in *1871*, the first *emulsion gelatin dry plate*. Now the chief technical difference between the collodion dry plate and the gelatin dry plate is that the collodion film was formed on the plate first and the coating of silver salt was put on it afterward, whereas with the gelatin dry plate the silver salt was mixed with the gelatin and the plate was then coated with this *emulsion* as it is called. While the sensitivity of the gelatin dry plate was about the same as that of the collodion dry plate it was vastly superior to it because the film was stronger. The way that these early dry plates were coated by hand is pictured in the frontispiece.

In *1878* Charles Bennett, also of England, found that by cooking the gelatin with the silver salts and potassium bromide the sensitivity of the emulsion was greatly increased. The higher speed and other advantages of the gelatin dry plate soon took the place of both the collodion wet and dry plates, and it marked the beginning of instantaneous photography and its concomitant marvels.

The first gelatin dry plates were manufactured commercially in *1872* by the firms of B. J. Edwards and Company, and Wratten and Wainwright, of London, by John Carbutt and Company, of Philadelphia, and the Seed Dry Plate Company, of St. Louis, Missouri. In *1880*, George Eastman, of Rochester, New York, began to make and market dry plates, and in *1884* the Eastman Dry Plate and Film Company was incorporated.

The Advent of the Films.—The idea of using films instead of plates dates away back to *1854* when Spencer and Melhuish, of England, proposed them and, strange as it may seem, they were so prepared as to enable the user to load his camera with them in daylight. The trouble with Spencer and Melhuish was that they were just three score years ahead of the photographic times.

A couple of years later Parks, of England, invented a compound

which he called *xylonite*[5] but which later on came to be known as *celluloid*,[6] as it resembles wood less than it does ivory. It is made by dissolving guncotton and camphor in alcohol, and when it is dried in sheets it is transparent, tough and flexible. John Carbutt, in 1884, made the first emulsion-coated *celluloid films.*

This was followed by the Eastman *paper film*, and this consisted of a paper base coated with a gelatin-silver emulsion like that which was used for glass plates. The paper film was the kind that was used in the first roll cameras. But it did not find favor, however, as the grain of the paper showed when a print was made from it.

The next development was the *stripping film* which was patented by the Eastman Company in *1884*, and it was made by coating a strip of paper with soluble gelatin which was, in turn, coated with the gelatin-silver emulsion. After the paper film was exposed and developed it was immersed in warm water when the film negative could be easily stripped from the paper base. Eastman marketed the roll-film camera under the now famous name of *Kodak* in *1887*, and the stripping film was used with it in *1888*.

The invention of the *celluloid roll film*, however, was due to Hannibal Goodwin, of Chicago, Illinois, who patented it in *1887*. After much litigation his patent rights were sustained and in *1889* it was marketed in rolls for the first time. As its name indicates, the celluloid film or *nitrocellulose film*, as it is also called, has its base formed of this material; it is coated with a thin layer of sodium silicate ($NaSiO_2$) first so that when the emulsion is put on, it will adhere firmly to it, and this is the film that is now in general use. The way that the film base is coated with the emulsion by machinery is shown in *Fig. 3*.

Up to this time the operation of changing the roll of film after it had been exposed in the camera for a fresh one had to be done in a darkroom, and as the amateur either had to have one of his own or else take it to a professional who had one, this untoward feature was the only remaining dipterous insect in the unguent. So in *1891* the technicians of the Eastman Company devised the first *daylight loading film*.

[5] From the Greek word "xinlon" which means *wood*.
[6] From *cellulose* which means *cell* plus oid, a suffix meaning *like*.

It consisted of a film with black cloth ends, and this was wound on a spool in a light-tight box; the latter was fixed in the camera and as the exposures were made it was wound up on a spool in another removable light-tight box. The last great improvement was made by winding the film inside of a sheet of opaque paper on a spool so that the light couldn't strike it; it could then be easily loaded into the camera when a fresh film was needed, and

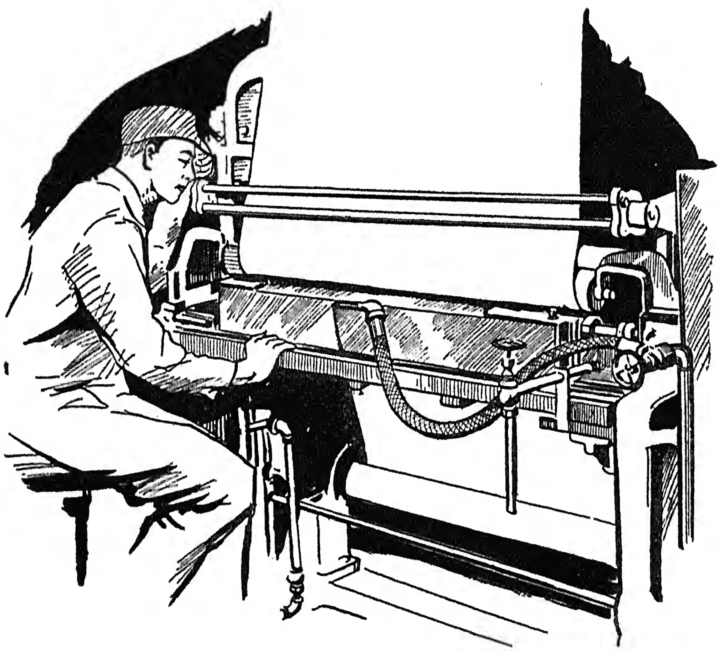


Fig. 3.—Coating the Film Base with the Emulsion by Machinery

removed when it had been exposed, and this is the way that practically all cameras used by amateurs are loaded at the present time.

Dry plates, however, were used exclusively by professional photographers clear up to *1921*, when the Eastman Company began the manufacture of *cut flat films*. For a long time after these were on the market many professionals still used dry plates because

they believed that they were clearer than the celluloid films. This idea was finally broken down and as they were much lighter, more compact and could not be broken, they finally all but superseded the glass dry plate for ordinary photographic work.

The Advances in Speed, Plates, and Films.—From the very beginning of photography the great desideratum has been to increase the speed of the plates and films, *i.e.*, to reduce the length of time that they had to be exposed to impress the latent image on them. This was done in various ways, but that of cooking the gelatin-silver emulsion marked the first great step.[7]

The following table shows how the time of the exposure was cut down from *3* hours in *1827* to 1/100,000 of a second in *1937*.

TABLE OF INCREASES IN SPEED

YEAR	INVENTOR	PROCESS	TIME REQUIRED FOR EXPOSURE
1827	Niepce	Heliograph (Asphalt)	3 hours
1839	Daguerre	Daguerreotype (Silver Plate)	30 minutes
1841	Fox Talbot	Calotype (Paper Negative)	3 minutes
1851	Scott	Collodion Wet Plate	10 seconds
1864	Sayce and Bolton	Collodion Dry Plate	15 seconds
1871	Maddox	Gelatin Dry Plate	15 seconds
1878	Bennett	Gelatin Dry Plate (Cooked Emulsion)	1/200 second

Color Sensitive Plates and Films.—When a plate or a film is coated with the ordinary emulsion of gelatin-silver salts and it is exposed in the camera, only the blue and blue-violet light rays act on it and these photograph as *white*, while green, yellow, orange, and red light have no appreciable effect on it and, it follows, they photograph as black. On the other hand, the eye is sensitive to green, yellow, orange, and red light and not very

[7] The technic of making high-speed emulsion plates and films is quite fully described in my *The March of Chemistry* published by *J. B. Lippincott Company*, Philadelphia and London.

much to blue and blue-violet light, hence the light response of the ordinary plate or film is just the opposite to that of the eye. Since this is the way of it, it is obvious, then, that the light values of the ordinary plate or film prevent the colors of the objects which are photographed from being correctly rendered when they are seen by the eye.

Nogel, of Germany, discovered in *1873* that when a plate was dyed *yellow* with *aniline dye* it was made sensitive not only to blue and blue-violet light but to the green rays as well. Then in *1882* Tailfer and Clayton, of France, found that when a plate was dyed with *eosin* it was made sensitive not only to the green rays but also to *yellow* and *orange light,* and, it follows, that the red rays only had no effect on it. Plates of this kind are called *isochromatic* and *orthochromatic,* and these were used by a few professional photographers at that time.

In *1884,* Nogel discovered that *cyanin,* an unstable blue dye, was a better yellow sensitizer for plates than either of the first named dyes. Finally Koenig, also of Germany, made the important discovery, in *1904,* that *pinacyanol,* a greenish dye, would sensitize the emulsion so that *red light* would act on it. Thus the plates and films which were coated with the dye-sensitized emulsion gives the true color values, *i.e.*, as the eye sees them, throughout the entire color range of the spectrum; the plates and films so treated are known as *panchromatic,* and they are widely used by the amateur as well as the professional photographers at the present time.

The Coming of Fine-grain Films.—With the coming of the motion-picture camera and its miniature film, emulsions were needed that had a *finer grain* than those which had been previously used, in order that there would be no loss of detail when the greatly enlarged pictures were projected on the screen.

To make *extremely fine grain* films they are coated with chloro- or bromochloride silver emulsions and the emulsion is then ripened by repeatedly heating and cooling it to give it speed. The three chief brands of fine-grain films that are now marketed by American firms are sold under the trade names of (*a*) *Panatomic,* which is made by the Eastman Company; (*b*) *Finopan,* and (*c*) *Micropan,* both made by the Afga Ansco Company.

CHAPTER II

HOW THE OPTICAL IMAGE IS FORMED

In order to take a photograph four essential things are necessary, and these are (*1*) light, or some other form of radiant waves, (*2*) a camera that is fitted with a lens and shutter, (*3*) a plate, film or some other light-sensitive material, and (*4*) the chemicals to develop and fix it. There are several other supplementary things but these will be explained as we push along.

The Concepts of Light.—Since light is the first essential element needed to take photographs, let's look a little into its nature first. Centuries before the mind of Man conceived the idea of taking pictures with the aid of light he sought for an explanation of what light is. From time to time various concepts were worked out to account for it and its phenomena, and some *250* years ago two outstanding ones were evolved; these are known as (*1*) the corpuscular theory, and (*2*) the undulatory theory, and one that has quite recently been put forward is (*3*) the neutronic theory.

The *corpuscular*, or *emission theory* as it is also termed, was developed by Sir Isaac Newton,[1] of England, and he conceived it as being formed of exceedingly minute particles of matter, or *corpuscles* as he called them, and these were assumed to be thrown off by the sun and all other luminous bodies, very like the way that sparks are thrown off by an emery-wheel. This theory failed in so many respects that it was eventually superseded by the *undulatory* or *wave theory*.

This theory, which was devised by Christian Huygens[2] (pronounced *Hi'*-genz), of Holland, was the universally accepted one until up to a few years ago, when Einstein put a damper on it by refusing to take the *ether* into consideration in working out

[1] He was a physicist and mathematician who lived from *1642-1727*.

[2] He was a physicist and a mathematician who lived from *1629-95*.

his formulas for relativity. According to the Huygens theory waves are set up in the ether by the rapidly vibrating particles of luminous bodies, somewhat as waves are formed in a rope when one end of it is moved rapidly forth and back.

What is called the *electromagnetic theory of light* originated in the fertile brain of Michael Faraday, of England, and it was later developed mathematically by James Clerk-Maxwell, also of England. It assumes that the exceedingly short waves that we call light are formed by alternate electric and magnetic rings which are linked together and that they are transmitted through the ether in accordance with the Huygens undulatory theory.

The recent *neutronic theory of light,* which has been suggested by the author, is no less electromagnetic in character than the Faraday-Maxwell conception states it to be but it is an improvement on the latter for the interlinking electric and magnetic rings of force are conceived to be formed of minute positive and negative charges of electricity that are called *positrons* and *electrons* respectively.

These positrons and electrons are normally bonded together as shown in the schematic diagram in *Fig. 4,* when they form a neutral particle of electricity, or *neutron* as it is called and, it follows, it does not then show any electrical properties whatever. Now in the very beginning of things all space, interstellar and otherwise, was filled with these neutrons and it is still filled with them except for the very small parts of it that are taken up by atomic matter, and it is these (the neutrons) which constitute the all pervading medium that is called the ether.

Different from the Newtonian corpuscular theory, it is not the result of the neutrons being thrown off from a luminous body that produces light, but it is the vibration of the atoms of the latter which sets them (the neutrons) into motion and these form waves in the surrounding space. A crude analagous illustration of the way that this is done are the waves that are set up in the air when a bell or other resonant body is struck and made to vibrate.

The Action of Light.—To understand how light forms an image on a screen, a plate, or a film, you must know what its chief characteristics are and how it acts. Now what we ordinarily call

light is the sensation that is produced in the visual area of the brain when light waves fall on the retina of the eye. Three factors are required before this action can take place and these are (1) a luminous body, *i.e.*, one whose atoms are in a state of rapid vibration, such as the sun or an electric lamp; (2) the ether which is formed of neutrons and in which the vibrating atoms of the luminous body sets up waves, and (3) the eye on whose retina,

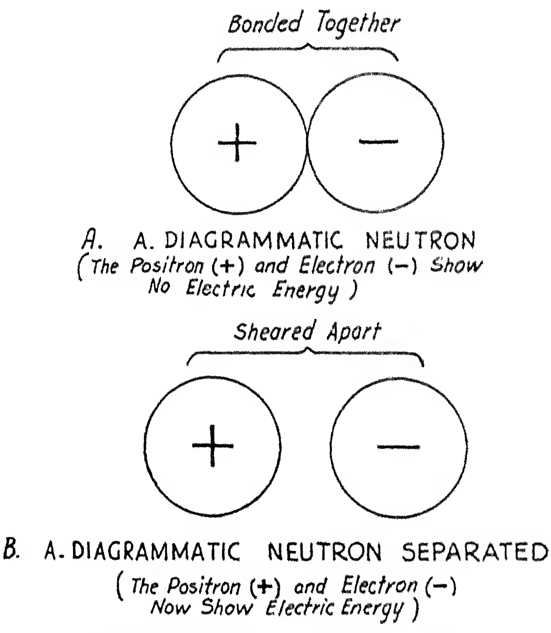


FIG. 4.—THE NEUTRON, POSITRON, AND ELECTRON

(The ether is formed of neutrons. When each neutron is sheared apart, it forms positive and negative electricity.)

or screen, the waves impinge and form the image. If any one of these three factors is missing there can be no light.

When you look at a lamp or other source of light which is sending out waves you are led to believe that you actually see them, but this is an optical illusion for light waves in and by themselves as they are traveling through space are invisible. To prove that this is so you need only to make a small hole in the

door of a perfectly dark room and let the light waves from the sun pass through it.

If the room is entirely free from dust and smoke you will not be able to see the beam of light waves; if, however, there are particles of dust or smoke floating in the air you will then apparently see the beam of light, but what you really see are the material particles that are floating around in the air, and this is because they are illumined by the light waves that strike them, when they (the particles), in turn, reflect them into your eye.

The Sources of Light.—There are two general sources of light, and these are (*1*) natural light and (*2*) artificial light. *Natural light* is that which is chiefly produced by the sun and the fixed stars, and while the moon and the planets are luminous the light that comes from them is only that which falls on them from the sun and is reflected by them. *Daylight* is, of course, natural light since it is that which is produced by the sun and falls directly on the earth.

What we call *artificial light* is that which Man makes for himself, but, in the last analysis, it is as natural as sunlight or starlight for however he produces it, be it by burning oil, wood or coal, or by electricity, the energy that is stored up in the former or the power that is used to generate the latter came originally from the sun. Now the two chief ways by which artificial light is produced are by (*1*) chemical action and (*2*) electrical action.

Light that is made by *chemical action* is produced chiefly by burning various substances in air, while that which is made by *electrical action* is the result of passing a current through (*a*) a wire when it will heat it to incandescence, (*b*) a rarefied gas which sets the atoms of it into rapid vibration, and (*c*) a pair of carbon or other electrodes whose adjacent ends are slightly separated.

Light Travels in Straight Lines.—You will remember that when you studied *Math*, the ancient Greek geometrician, Euclid, demonstrated by means of a minute hole in a board that *light travels in straight lines*. You can repeat the experiment by getting three sheets of cardboard, each of which is, say, about *8* inches wide and *12* inches long, and fasten one end of each one to a strip of wood. This done make a good-sized pinhole in the center of each sheet, and these must be *exactly* in a line with each other.

Now set the sheets about a foot apart and fix an electric lamp back of the pinhole in one of the end sheets and look through the pinhole in the other end sheet, as is shown in *Fig. 5*. Since light travels in straight lines the rays will pass through all of the holes and you will be able to see a part of the lamp.

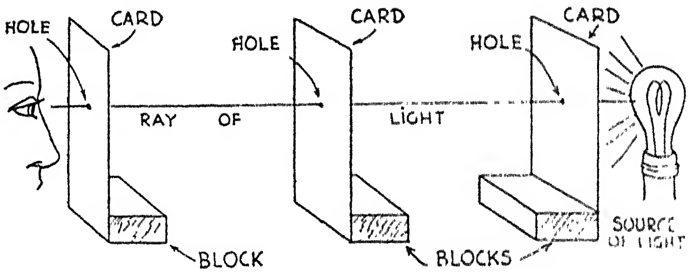


FIG. 5.—PROOF THAT LIGHT RAYS TRAVEL IN STRAIGHT LINES

The Intensity of Light.—The term *intensity of light* means, of course, the strength of it at any given point. Now the farther light waves get away from the source that sends them out the fainter they become and this decrease in the energy of them is in a definite ratio. Since light waves travel out from the source that radiates them in all directions and each *ray*, as a line of light waves is called, decreases in the same ratio as that of the other rays the amount of surface that they can light up depends on the distance it is from the source.

Thus let *a* in *Fig. 6* represent a source of light and *b* a square cardboard surface at a distance from *a* of, say *1* foot; now at twice this distance, *i.e.*, at *c* they spread out over *4* times the area that they covered at *a*, when, it follows, the intensity of the light that falls on the surface is only ¼ as great as that which covers *a*. At three times the distance from the source, see *d*, the light covers *12* times the area as it does at *A* and it is, therefore, only $\frac{1}{12}$ as intense; at *4* times the distance, see *e*, it covers *16* times the area, and it has only $\frac{1}{16}$ the intensity. Since this is the way of it the amount of light that reaches the surface of an object is *inversely proportional to the square of the distance*, or to put it a little more simply, *light decreases as the square of the distance*, and this is called the *law of inverse squares*.

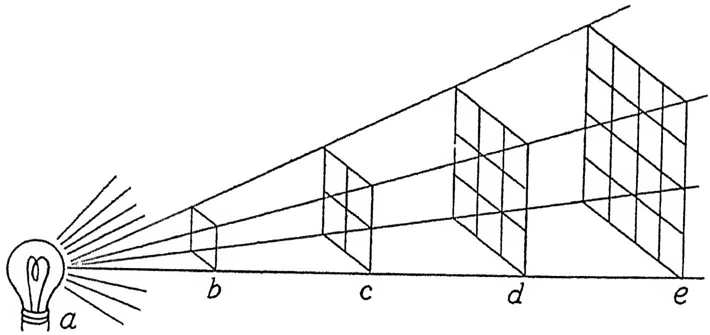


FIG. 6.—HOW THE INTENSITY OF LIGHT DECREASES AS THE SQUARE OF THE DISTANCE

(The law of inverse squares.)

How Light Is Reflected.—Rays of light may be either (*1*) direct or (*2*) reflected. *Direct light* is that which is produced by the sun, electric lamp, or other kind of a luminous body, while *reflected light* is produced by direct light that falls on a non-luminous object and which is turned back and sent out in a direction that is at an angle to the direct light.

You can get a rough idea of the way that rays of light are reflected from a surface by bouncing a solid rubber ball on a sidewalk. At whatever angle that you throw the ball on the walk, provided the latter is horizontal and perfectly smooth, it will bounce back at the same angle, but in the opposite direction as shown at *A*, *B* and *C* in *Fig. 7*, and light waves behave in exactly the same way. The ray of direct light is called the *incident ray*, and the ray of returning light is called the *reflected ray*, while the angle of the incident ray and the reflected ray is called the *angle of incidence.*

There are two kinds of surfaces from which light is reflected and these are (*a*) a smooth surface, and (*b*) a rough surface. When light is reflected from a *smooth surface* as, for example, a sheet of even glass, the rays of light which fall on it are reflected from its surface with great uniformity, as shown at *A* in *Fig. 8*, and this is called *regular* or *specular* reflection.

If, now, you will get a sheet of ground glass, or grind one side of a sheet of even glass with a little coarse emery and some ma-

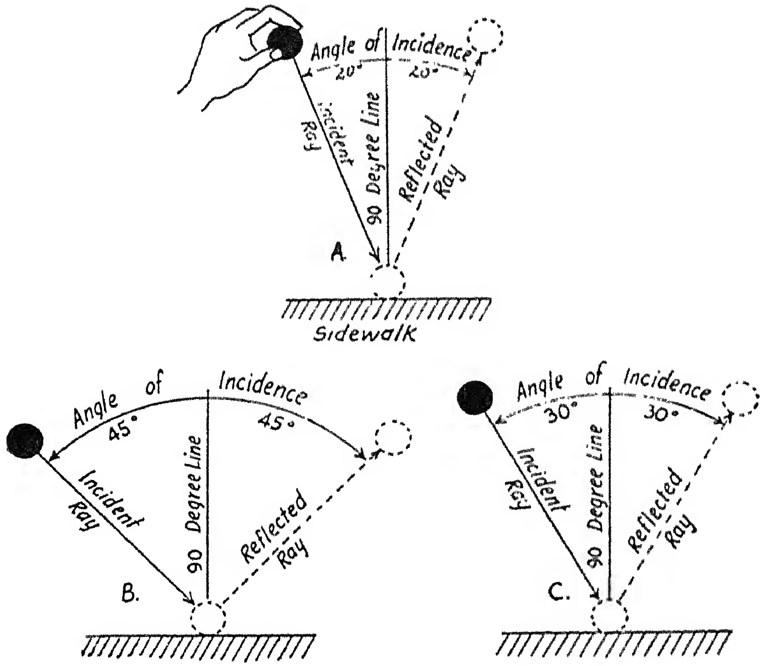


FIG. 7.—ANALOGUE OF THE REFLECTION OF LIGHT
(Reflection of a bouncing ball.)

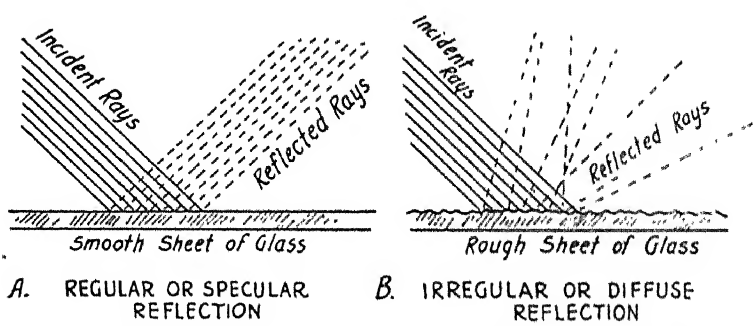


FIG. 8.—THE REFLECTION OF LIGHT FROM SMOOTH AND ROUGH SURFACES

chine oil, the law of the angle of incidence still holds good but owing to the roughness of the surface due to the minute areas that the incident rays fall on and which are at every conceivable angle, the reflected rays travel out from them in numerous directions as pictured at *B*, and this is called *irregular* or *diffuse reflection.* When you take a photograph of a luminous body the light sent out by it travels in a straight line to the plate or film, but when you take one of a non-luminous body the light that falls on it is bent back and it is the reflected light which impinges on the plate or film.

Further and finally all objects, whatever their color may be, reflect light. A *white* surface reflects practically all of the light that falls on it; *blue* reflects nearly all of it and the rest of it is absorbed; *green* reflects less than blue, and more of it is absorbed; *yellow* reflects still less than green, and, hence, still more of it is absorbed; *red* reflects only a little of it while the larger part of it is absorbed; and lastly, black absorbs all of the rays that fall on it and, it follows, none of them are reflected.

How Light Is Refracted.—When a ray of light passes through any substance whose density is uniform, such as air, water, glass, etc., it travels in a straight line, but if it passes from one substance to another whose densities are different then it (the ray) will be bent out of its course, and this is called *refraction.*

A simple experiment to illustrate the refraction of light is (*1*) to look through a sheet of glass at a coin so that the rays that are reflected from the latter will pass through it to your eye at right angles to the surface of the glass as shown at *A* in *Fig. 9.*

Having done so, (*2*) look at the coin through the glass at an angle of, say, *45* degrees when instead of seeing it (the coin) where it really is you will apparently see it in a straight line with your eye as indicated by the broken line at *B*. This illusive effect is, as I have previously pointed out, due to the different densities of the air and the glass and, hence, the rays are bent when they pass into the glass, and are bent again when they leave it.

Why Light Is Refracted.—To know why rays of light are refracted we must consider the undulatory theory which says that the waves of which the rays are formed are transverse vibrations

in and of the ether, and this holds good for the neutron theory as well, which is simply an improvement on it.

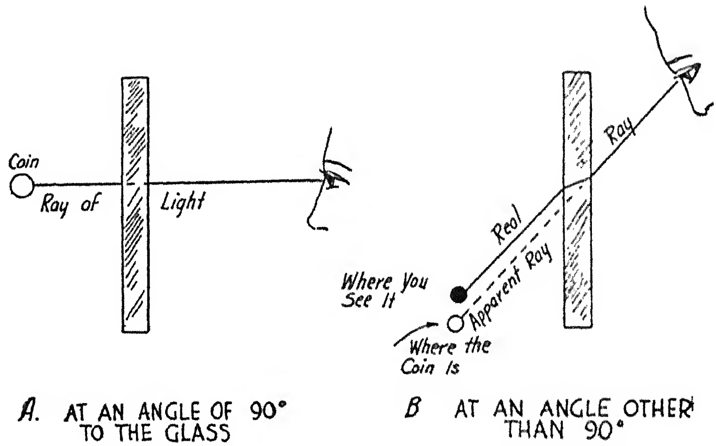


FIG. 9.—HOW A SHEET OF GLASS REFRACTS LIGHT

A diagrammatic representation of a ray of light is shown at *A* in *Fig. 10,* and it is formed of transverse vibrations of the neutrons that are parallel with each other and at right angles to the direction which the ray is traveling—very like buttons strung on a string. Now when a ray passes obliquely from the air into

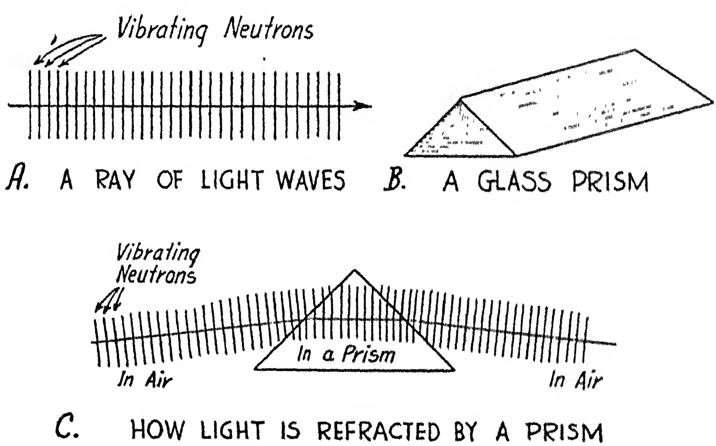


FIG. 10.—HOW A PRISM REFRACTS A RAY OF LIGHT

water, glass, or other media, that is at some other angle than *90* degrees, the latter retards the movement of it because one end of the transverse vibration enters it before the other end does, and this slows it down and swings it out of its normal straight line.

The way in which a prism bends the vibrating neutrons and, hence, the ray of light, out of a straight line is pictured at *C*. The refraction of light is a very important factor in photography as the formation of images by lenses is based on the principles of it as you will presently see.

How Light Forms an Image.—What we call an *image*[3] is an apparent picture of an object, and there are three chief ways by which it can be formed, and these are by (*1*) the reflection, (*2*) the projection, and (*3*) the refraction of light. To produce an image by *reflection* the light from an object must fall on a smooth, bright surface when it can be seen by the observer.

To form an image by *projection* the light from the object must pass through a *small hole* when it will be seen on the opposite side of the room or camera, and, lastly, to produce an image by *refraction* the light of the object must pass through a *lens* when it will be formed on the screen, plate or film of the camera.

What Virtual and Real Images Are.—There are two kinds of optical images and these are (*1*) the virtual image and (*2*) the real image. What is known as a *virtual image* is one that has no definite focus, and this is formed by the reflection of rays of light, as, for example, those that are bent back by a plane mirror, and which produce the visual impression on the observer that it (the image) is back of it at the same distance as the object is in front of it.

Oppositely a *real image* is an actual picture that is formed on a screen, plate or film by the rays of light that come either directly from or which are reflected by an object. It is the production of the real image that we are interested in here and there are two ways that it can be formed, namely, (*1*) by a pinhole and (*2*) by a lens.

How Light and a Pinhole Form an Image.—Knowing that light normally travels in straight lines it is easy to understand how

[3] We get the word *image* from the Latin *imago* which, in turn, is derived from the root *imitari* meaning to *imitate*.

the rays that come from a luminous source, or those that are reflected by an object form an image when they pass through a pinhole and also why it is inverted, *i.e.*, upside down.

To demonstrate the theory of the formation of an image by means of a pinhole take a couple of sheets of cardboard that are about *8 x 10* inches on the edges and make a sharp pinhole in the center of one of them. This done fix one end of each one to a strip of wood and set them about a foot apart on a table with their surfaces parallel with each other. Now place a lighted electric lamp in front of the cardboard that has the pinhole in it, when an inverted image of it (the lamp) will be formed by the rays that pass through the pinhole on the cardboard screen as pictured in *Fig. 11*.

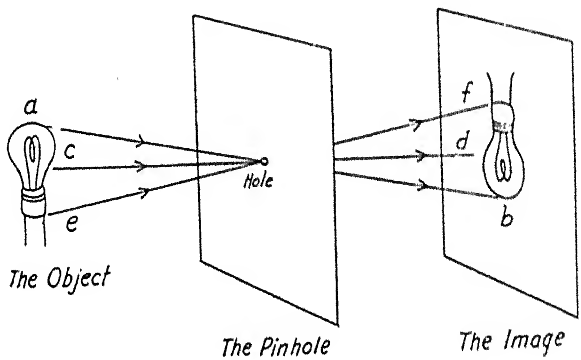


FIG. 11.—HOW LIGHT AND A PINHOLE FORM AN IMAGE

The explanation is simple: Since light rays travel in straight lines those that start from the top of the lamp at *a* and are in a line with the pinhole will pass through it and reach the screen at *b*; likewise those rays that start from the middle of the lamp at *c* which are in a line with the pinhole will pass through it and fall on the screen at *d*; those that start from the bottom of it at *e* and are in a line with the pinhole will impinge on the screen at *f*, and so on from every part of the lamp. As practically all of the rays vary in intensity when they fall on the screen they produce different amounts of light and so build up a complete image of the lamp, or other object.

The distance of the lamp from the pinhole and the latter from the screen determines the intensity of the rays that form the image and, it follows, the brightness of it, and also the size of it. To demonstrate this you need only to vary the distance of the lamp and the screen from the pinhole. By means of the following algebraic formula you can find the size of the image for any given distance:

$$\frac{DO}{DI} = \frac{LO}{LI}$$

Where LO is the length of the object, LI the length of the image, DO the distance of the object from the pinhole, and DI the distance of the image from the pinhole, which means that you divide the length of the object by the length of the image, and this equals the distance of the object from the pinhole divided by the distance of the image from the pinhole.

The image that is formed by a pinhole is always *in focus*, that is it is equally sharp no matter how close or far away the lamp or object, or the screen may be from it, and this is due, of course, to the fact that the rays from the former which pass through it and fall on the screen travel in straight lines. In this respect the image formed by a pinhole is different from that which is produced by a lens since the latter refracts or bends the rays and in order to produce a sharp picture these must be brought to a focus.

How Light and a Lens Form an Image.—A *lens* is a piece of glass the two opposed surfaces of which are either (*a*) curved, or (*b*) one of which is curved and the other plane.

A *convex* lens is one whose opposed surfaces are curved outward as shown at *A* in *Fig. 12*. Now when a ray of light passes through any part of a lens it is refracted, that is, bent out of the straight line, just as it is when it passes through a sheet of glass at an angle or through a prism, and for the same reason which I have already explained; the result is that the rays after passing through a convex lens will come to a point at a definite distance from the center of it (the lens), as pictured at *B*, and this is called its *principal focus*. The distance from the longitudinal center of the lens to its principal focus is called its *focal length*, as shown at *B*.

The rays that come from the upper part of the object will, naturally, fall on the upper part of the lens and in passing through it they will be refracted at a downward angle. In the same way the rays from the lower part of the object will fall on the bottom

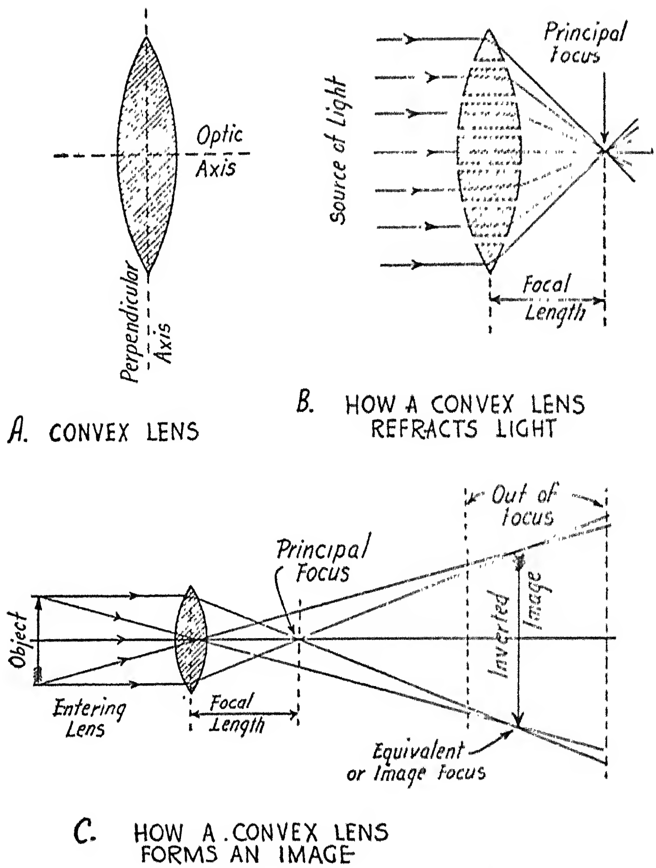


FIG. 12.—HOW LIGHT AND A LENS FORM AN IMAGE

part of the lens and on passing through it they will be refracted upward. The rays of light from the center of the object will fall on the center of the lens and these will pass through it in a straight line.

If a screen or other surface is placed close enough to the lens so that all of the rays come to a common point, *i.e.*, at its principal focus, a bright point of light will result, but if the screen or surface is moved farther away from the lens the rays will continue to travel on until, finally, those from the upper part of the object that pass through the top of the lens and the center of it will cross each other at the bottom of the latter, while those from the lower part of the object that pass through the bottom of the lens and the center of it will cross each other at the top of the latter as shown at *C*.

The points where these rays cross is variously called the *equivalent focus,* or *image focus,* or *focal plane* of the lens and it is here that the image is the sharpest, or *in focus* as it is termed. If you move the screen away from the image focus either toward or back from the lens, the image on it (the screen) will be more or less blurred, or *out of focus* as it is called. In order to focus the image sharply on the screen, plate, or film of a camera, the latter is often provided with a sliding or a rack-and-pinion movement, so that the distance between lens and film can be accurately adjusted.

When a certain critical distance between the object and the lens is reached and the screen, plate, or film is fixed at this point, not only the object but everything back of it will be in focus, and this is the reason it is possible to make a *fixed-focus camera,* as, for example, the *Brownie* and other little box cameras.

The *concave lens* differs from the convex lens in that its opposed surfaces curve inward, but as with a convex lens when a ray of light passes through any part of it it will be refracted toward its thickest part. The result of this action is to make the rays of light that pass through it *diverge,* that is spread out, and so only a virtual image can be formed with it.

The only way to make the rays that pass through it come to a point, *i.e.,* to focus them, is to reflect them back through the lens to the side where the rays come from as shown in *Fig. 13,* and this is called its *principal focus.* The concave lens, then, cannot form a real image and where it is used to make up a compound lens for a photographic objective it is employed for corrective purposes only.

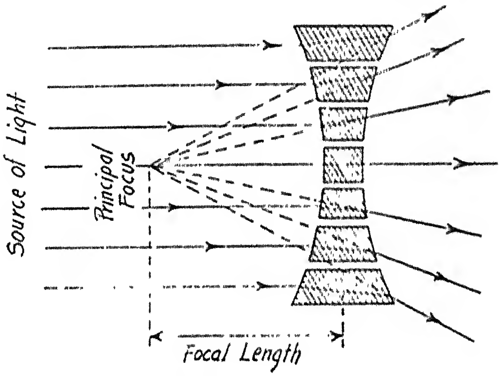


FIG. 13.—HOW A CONCAVE LENS REFRACTS LIGHT

How Light Waves Form Colors.—What we call *color* is a sensation that is set up by the nerves of the eye in the visual center of the brain, and it is entirely different from those sensations that we perceive and take cognizance of as form, or light, or shade. Various colors are the result of light waves of different lengths acting on the retina of the eye; thus the longest visible waves, *i.e.*, those that act on the retina of the eye, produce the sensation of *red*, while the shortest visible waves produce the sensation of *violet*, and the wave lengths in between these two extremes produce indigo, blue, green, yellow, and orange.

The above are called the *primary colors*, and the following table gives the wave lengths that produce them, the number of them to the linear inch, and the number of them that pass a given point in one second.[4]

From this table, you will observe that there are seven different visible wave lengths and that these produce seven primary colors. Now some luminous bodies, such as the sun and an arc-light, set up all of these seven different lengths of waves and when they fall on a surface that will reflect all of them they produce the sensation of *white*. If they fall on a surface that absorbs all of them, there will be no reflection and, it follows, no sensation, hence the surface will appear to be *black*.

[4] Light travels about *185,300* miles per second.

TABLE OF COLOR WAVE LENGTHS

COLOR	LENGTHS OF WAVES IN 10-MILLIONTH OF AN INCH	LENGTHS OF WAVES IN 1-MILLIONTH OF A MILLIMETER. (MILLIMICRONS)	NUMBER OF WAVES IN ONE INCH	NUMBER OF WAVES IN ONE SECOND
Violet	157	400	63,694	699,000,000,000,000
Indigo	170	430	58,823	658,000,000,000,000
Blue	181	460	55,249	622,000,000,000,000
Green	211	520	47,460	577,000,000,000,000
Yellow	227	590	44,000	535,000,000,000,000
Orange	240	630	41,610	506,000,000,000,000
Red	266	680	39,180	477,000,000,000,000

How to Produce the Primary Colors.—To separate out the various wave lengths and make them form the different primary colors you need only to repeat the classic experiment of Sir Isaac Newton. To do so make the room where you are going to perform it in perfectly dark; now cut a slit $\frac{1}{32}$ of an inch wide and $\frac{3}{4}$ of an inch long in a sheet of heavy opaque paper, and fix this over a window that faces the sun so that the rays of light of the latter will pass through it.

This done suspend, or otherwise support, a prism in front of and at right angles to the slit so that the rays from the latter will pass through it; place a cardboard screen at a little distance from the prism when the beam of light that falls on it will separate out the different wave lengths by refraction, and when these strike the screen they will set up the various sensations of color as pictured in *Fig. 14*.

The same action takes place when rays of light of different wave lengths are reflected from an object, then pass through a lens and form an image on the screen, plate or film, that is they not only produce an image of the object but the colors of it as well.

Now while you can see the image of an object in its natural colors when it is projected on a screen, when you make a negative of it it will be in black and white, and without a trace of the colors that can be seen by the eye on the screen. This is because all of the various wave lengths act chemically on the silver

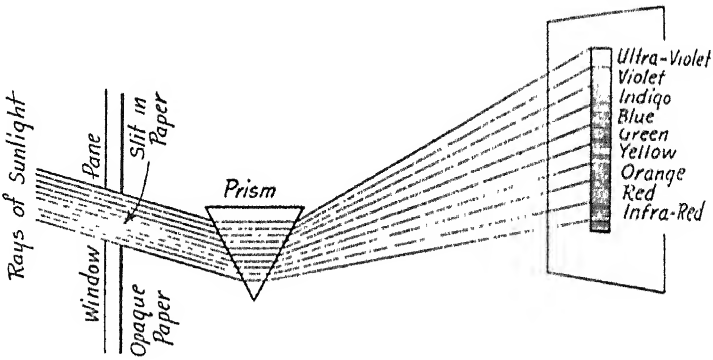


FIG. 14.—HOW LIGHT AND A PRISM FORM COLORS

(The ultra-violet and infra-red rays cannot be sensed by the eye, but they affect a photographic plate or film.)

salts of the plate or film in exactly the same way, and this turns it more or less black where it falls on it depending on the intensity of the rays.

To take pictures in natural colors has been the dream of cameramen ever since the time that photography was invented. No chemical process has been devised by which it can be successfully done in practice. Photographs in natural colors are, however, produced in a round-about way, that is, by various ingenious mechanical processes, and these will be described in a later chapter.

CHAPTER III

LENSES AND THEIR ACCESSORIES

I. LENSES, THEIR DEFECTS AND CORRECTION

WE HAVE the written word of the Egyptians that *glass* was known as long ago as *3,500* years *B.C.*, and pictures of the way it was made are shown on tombs that date back to *2,500 B.C.* The earliest known glass was of an opaque variety and transparent glass was invented about *660 B.C.*, and by this time the glass workers had learned how to blow it into various shapes.

The Coming of the Lens.—The lens had its real beginnings when the ancient Greeks and Romans made glass bulbs and filled them with water. These were used as *burning glasses,* and it is obvious that they also knew about their magnifying properties. In reading ancient history and especially novels having an ancient historical background, instances are occasionally cited which would lead you to believe that the early peoples were not only acquainted with the simple convex lens but used it as an aid to the eye.

Now, according to E. Wilde, of Germany, and T. H. Martin, of France, who made a special study of the origin of the lens, this idea appears to be entirely erroneous. Just when the first real lens was invented is not with certainty known but the earliest recorded description of its magnifying properties was given by Alhazen, of Arabia, a philosopher and mathematician, who thrived in the *eleventh* century.

It was not until the *thirteenth* century, however, that simple convex lenses were used for aiding the impaired vision of the aged. The credit for the invention of *spectacles,* as a pair of lenses set in a frame and held in place by bows passing over and back of the ears are called, is sometimes given to Alexander de Spina, of Pisa, Italy, in the *twelfth* century, and also to Salvino d'Armato degli Armati, of Florence, Italy, about the middle of the *thir-*

teenth century. The first picture that showed them in actual use was painted by Tommaso de Modena, of Italy, in the *fourteenth* century, and the picture is now in the church of San Nicola in Trevisco.

By placing two single lenses together Johann and Zacharias Janssen (father and son), of Holland, in the latter part of the *sixteenth* century, produced the first *compound lens*. Johannes Kepler, of Germany, in the *seventeenth* century, greatly increased the effectiveness of both single and compound lenses by formulating laws for their curvatures which would produce the sharpest images.

The compound lens was highly improved upon by John Dolland, of London, in the *eighteenth* century, when he invented the *achromatic lens*, and this he did by cementing a convex lens made of crown glass to a concave one made of flint glass, with the result that the lens was practically free from chromatic aberration.

Since still better lenses were needed for various optical instruments, such as the microscope, the telescope, and the camera, the great glass works of Jena, Germany, began an intensive research into the qualities of different kinds of glass, in the attempt to find better ones. This resulted in the discovery of *19* new kinds in *1886*; then *24* new ones were found in *1892* and *8* more were added to the list in *1898*.

While a number of these new kinds of glass possessed no properties that were of optical value, some of them showed surprising results and were vastly superior to those of the crown and flint kinds that had been used up to this time, and thus began a new era of lens making.

Kinds of Lenses.—The first requisite for making good photographs is a lens that is as free as possible from optical defects, and the kind that you will get will depend very largely on two chief factors, namely (*1*) the class of work you are going to use it for, and (*2*) the amount you can spend for it.

Now before we go into the details of the different makes of photographic lenses, or *objectives* as they are technically called, there are a few things you should know about simple lenses, such as (*a*) the different shapes of them, (*b*) the kinds of glass they are made of, (*c*) their optical defects, (*d*) how they are corrected,

and, lastly, (*e*) how they are combined to give various results and to increase their speed.

The Shapes of Simple Lenses.—Lenses have two fundamental shapes and these are (*1*) convex, or positive convergent, and (*2*) concave, or negative divergent. Names of the *convex* or *positive convergent* lenses are (*a*) the double convex or biconvex, (*b*) the plano-convex, and (*c*) the concavo-convex, converging or positive meniscus[1] lens; while the *concave* or *negative divergent lenses* are (*a*) the double concave or biconcave, (*b*) the plano-concave and (*c*) the concavo-convex, diverging or negative meniscus lens, and these are all shown in *Fig. 15*.

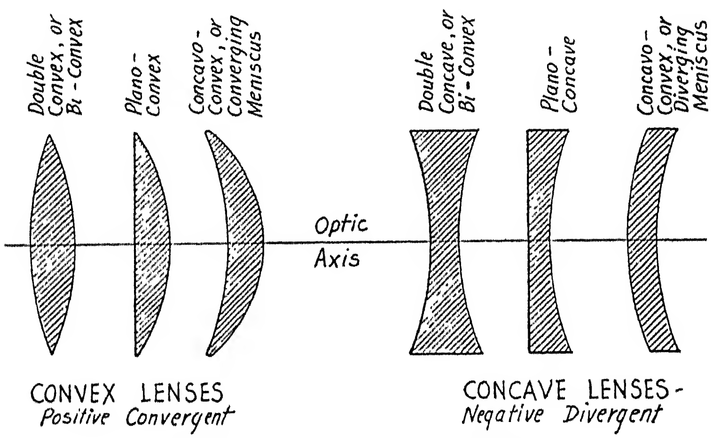


FIG. 15.—THE SHAPES OF LENSES

Now by making these various kinds of simple lenses of certain kinds of glass, grinding them to given curvatures and mounting them in definite combinations, the defects will be reduced to a minimum, they will let more light through them, and adapt them to serve special purposes.

The Defects of Lenses and Their Correction.—Lenses are subject to at least seven defects and these are (*1*) spherical aberration, (*2*) chromatic aberration, (*3*) distortion, (*4*) astigmatism, (*5*) coma, (*6*) curvature of the field, and (*7*) unequal illumina-

[1] The word *meniscus* comes from the Greek *meniskos* which means crescent-shaped, and this was derived from "mene" meaning the *moon*.

tion. If a perfect image of an object is to be projected by a lens these defects must be compensated for and the way that this is done will be explained as we push along.

Spherical Aberration.—In optics the word *aberration* means that the curvature of a lens is such that the rays of light are prevented from converging at a single point and, it follows, it will not form a sharp image. What is called *spherical aberration* is caused by a defective curvature of a lens and this makes the various parts of it refract the rays of light unequally.

The result of this untoward action is to cause the rays to converge at two different points on the optic axis, the rays that pass through the margin of the lens coming to a focus nearer to it

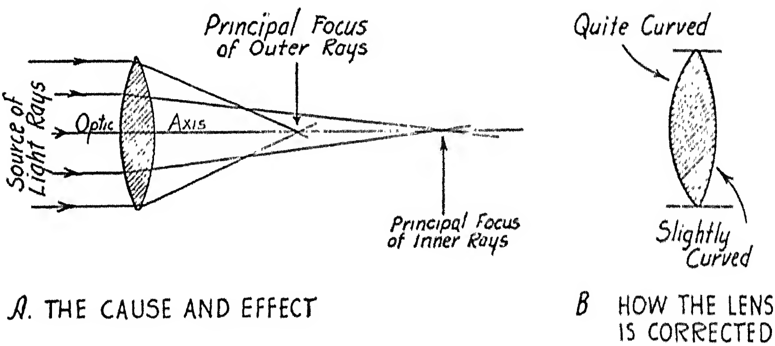


FIG. 16.—THE CAUSE AND EFFECT OF SPHERICAL ABERRATION

than those which pass through the center of it as shown at *A* in *Fig. 16*. The spherical aberration of a double convex lens is greater than that of a plano-convex lens, and it is more pronounced with the latter when the rays strike the flat side of it first than when they strike the curved side of it.

To show the amount of spherical aberration of a lens cover the center of it with a small disk of paper so that the rays will pass through the margin of it (the lens) only, and then measure its focal length, *i.e.*, the distance between the middle line of the lens and the point where the rays meet. This done place a paper ring on the lens so that the rays will pass through the center of it only and again measure the focal length. If, however, there is the

slightest difference in the two foci[2] of the lens it proves that it has definitely the defect of spherical aberration.

Now there are two ways by which spherical aberration can be corrected and these are (*a*) to grind the opposite sides of the lens to different curvatures, as at *B* in *Fig. 16*, and (*b*) to place a *diaphragm*, or *stop* as it is called for short, that is a thin metal strip or disk with a small hole in the center of it, on one side of the lens so that the rays will pass through the central part of it only. When the lens is thus *stopped down* the spherical aberration will be circumvented and, it follows, the image will be sharp, but the number of light rays that passes through it will

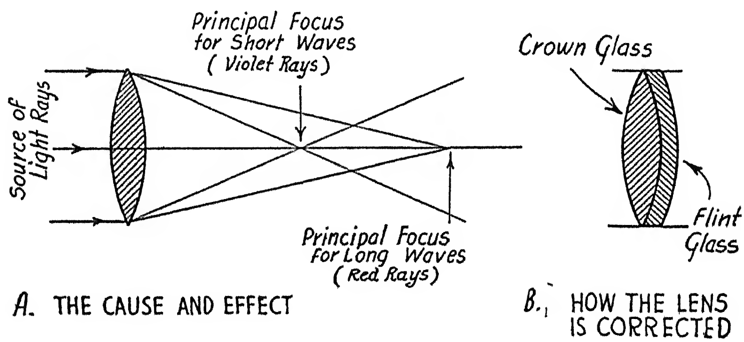


FIG. 17.—THE CAUSE AND EFFECT OF CHROMATIC ABERRATION

be proportionately less, and, of course, a longer exposure will be needed.

Chromatic Aberration.—The term *chromatic aberration* means that when rays of light whose waves are of different lengths, and, hence, which form the various colors of the spectrum, pass through a lens they are refracted unequally by it; the result of this unequal refraction is that the rays which are formed of the shortest waves, and which produce the sensation of violet, are bent out of their course at a greater angle than those which produce the sensation of red. This difference in the refraction of light rays formed of various wave lengths cause them to come to a focus at points that are separated a little from each other as shown at *A* in *Fig. 17*.

[2] This is the plural of *focus*.

To find out if a lens produces chromatic aberration you need only look through it at the edge of a sheet of paper and if so you will see that it takes on the colors of the spectrum, and this a single convex lens always does. To correct the defect of chromatic aberration a *compound lens* is used, that is one which is formed of a concave lens made of flint glass[3] and has a low refractive power with high dispersion, and the other a convex lens made of crown glass[4] which has a high refractive power with low dispersion, as pictured at *B*. These two lenses are ground so that the chromatic aberration which is produced by the one is counteracted by the other and, consequently, all of the rays come to a focus on the plate or screen at the same point.

Distortion.—In photographic parlance the word *distortion* is used to mean that a lens will not give a straight line image of an object as such, but instead, will reproduce it as a curved line. In ordinary view and portrait photography the defect of distortion may not be very noticeable, but in copying and architectural work it is highly obvious. Now there are two kinds of distortion and these are (*a*) negative, or barrel distortion, and (*b*) positive, or pincushion distortion.

Thus if you place a stop in front of the lens, as shown at *A* in *Fig. 18,* a rectangular figure will give a *negative,* or *barrel* image, and, oppositely disposed, if you place the stop back of the lens, see *B,* the rectangular figure will give a *positive,* or *pincushion* image. In order to correct distortion two like lenses can be used and the stop placed between them as at *C,* when the negative error of the one will be neutralized by the positive error of the other, and this is the way that *rectilinear lenses,* that is, lenses which give straight-line images, are made.

Astigmatism.—We get the word *astigmatism* (pronounced as-*tig′*-ma-tism) from the Greek roots *a* which means *not* and *stigma* meaning *spot.* Astigmatism is a defect in a lens which prevents the light rays that are set up at one point from being brought to a single focal point and, it follows, that an imperfect image will be formed. This defect causes the lines of the image

[3] Flint glass is made by melting sand, lead, and soda together.
[4] Crown glass is made by melting sand, lime, and soda together.

which have the same direction to be distinct while those lines that are at right angles to the former to be indistinct.

Astigmatism is a by-product of spherical aberration and to correct it, the lens is made of a special kind of glass, that was invented by Abbe and Schott, of Jena, Germany, in *1884,* and

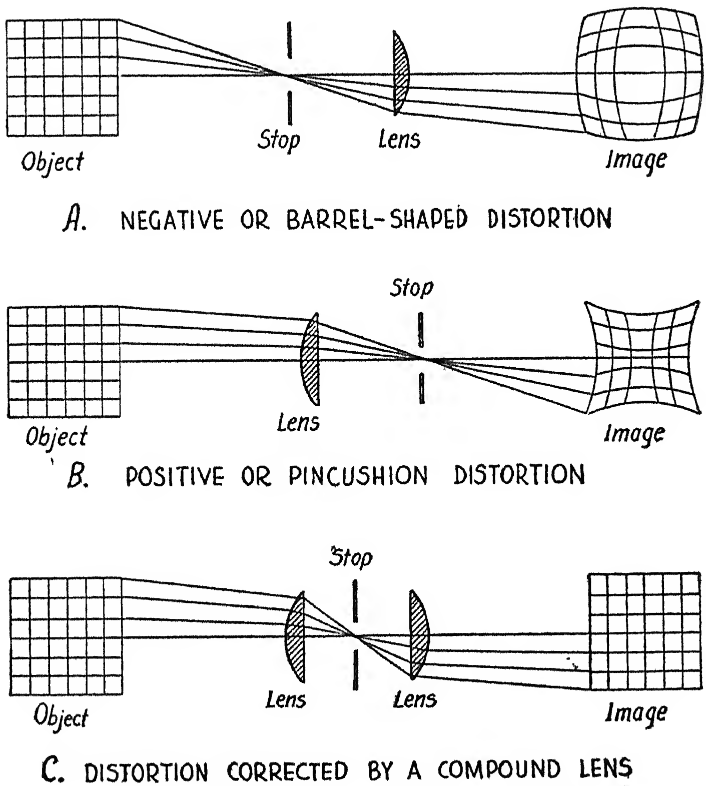


FIG. 18.—DISTORTION AND ITS CORRECTION

which has barium, boron, and phosphorus as its chief constituents. Lenses made of *Jena glass,* as it is called, reduce the defects of spherical and chromatic aberration and astigmatism to a minimum, and at the same time they have a high light transmission, *i.e.,* the rays pass through them much more freely than when they are made of crown or flint glass.

These good qualities give images that are uniformly sharp from the center of the plate or film to the very edges of it and this without stopping them down. Further, the lenses are ground and combined in accordance with the very latest mathematical formulas. Photographic lenses that obviate the defects of astigmatism are called anastigmats (pronounced an-*as′*-tig-mats)[5] and these will be described a little further along.

Coma.—In optical parlance *coma* is a blur of light that extends from and partly surrounds an image formed by a lens and this is caused by oblique spherical aberration. It can be corrected either by (*a*) using a diaphragm or stop, or (*b*) by compen-

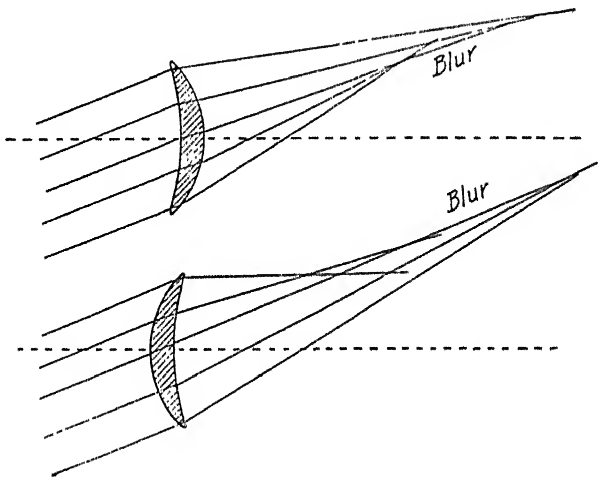


FIG. 19.—BLURRING PRODUCED BY COMA

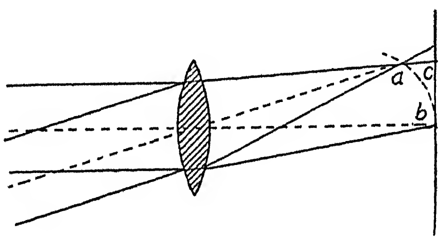
sation. By placing a diaphragm or stop in front of the lens the oblique rays of light will be cut off and, it follows, the amount of coma will be reduced. The better way, however, is to reduce it by *compensation*, that is, by neutralizing the coma produced by one lens with that which is produced by another lens. Diagrams of two kinds of coma that are produced by a single concavo-convex lens are shown at *A* and *B* in *Fig. 19.*

Curvature of the Field.—Since the surface of a plate or film

[5] From the Greek root *an* which means *not* and *astigmat*, meaning with or pertaining to astigmatism.

is always a plane, *i.e.*, flat, it is necessary that the image formed by the lens should likewise be a plane if it is to be in perfect focus. If the image is slightly curved it is obvious that it will not be sharply defined, as is clearly shown in *Fig. 20.*

The amount of the *curvature of the field,* as it is called, of a lens depends on several factors, the chief ones of which are (*a*) the kind of glass it is made of, (*b*) the thickness of it, (*c*) the separation of the components, (*d*) the position of the diaphragm or stop, and (*e*) the distance of the object from it. In lenses of whatever kind, curvature of the field is always present, especially in the ordinary ones, but with the anastigmats it is reduced to a minimum.



a b c = Curvature of Field

FIG. 20.—THE CURVATURE OF THE FIELD PRODUCED BY A CONVEX LENS

Unequal Illumination.—The light rays that pass through a lens vary in strength when they reach the plate or film and so produce what is termed *unequal illumination* or *diminution of intensity.* This falling off in the intensity of the light as it reaches the plate or film is due to three chief causes, namely, (*a*) the constriction of the aperture for the marginal rays, (*b*) the greater focal length of the marginal rays, and (*c*) the greater focal length of the angular rays.

In the first instance the smaller the aperture of the lens, *i.e.*, the more it is stopped down, the less the intensity of the rays will be that pass through it at an angle; second, the rays that pass through the margin of the lens have a greater length than those which pass through the center of it, and, lastly, the rays that pass through the lens at an angle have a greater length than those that pass directly through it as *Fig. 21* clearly shows.

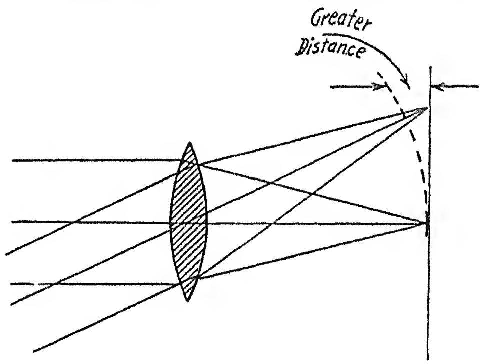


FIG. 21.—THE GREATER FOCAL LENGTH OF ANGULAR RAYS

II. KINDS OF PHOTOGRAPHIC LENSES

While a single positive convergent lens, *i.e.*, a convex lens of any shape, will form an optical image and it can, therefore, be used as a photographic lens or objective, the kind that is employed in even the cheapest cameras are made of special glass and are ground to conform to formulas that are mathematically worked out. Now there are three types of lenses and these are (*1*) the single lens, (*2*) the achromatics, and (*3*) the anastigmats.

The Fixed-focus Camera Lens.—What is called a *fixed-focus lens* is one that is used in a camera in which the plate or film is always at the same distance from it, that is, it cannot be focused. Now to understand how sharp images can be formed with a fixed-focus lens you need only to know that when the image it forms is sharp every object back of it will also be fairly sharp.

While a double convex lens can be used to form an image it is useless as a photographic objective because it is quite impossible to obtain a sharply defined image unless it is stopped down with a very small diaphragm, and when this is done there will be a great loss of light rays and, it follows, of speed.

A very much better image can be formed with a *concavo-convex* or *converging meniscus lens* when placed with its *concave side* toward the object that you are photographing for it will give

a fairly sharp image over a small field. For this reason a single converging meniscus lens, which is shown at *A* in *Fig. 22*, is used in the very cheapest of the fixed-focus cameras. In better fixed-focus cameras the single achromatic meniscus lens, see *B*, is used.

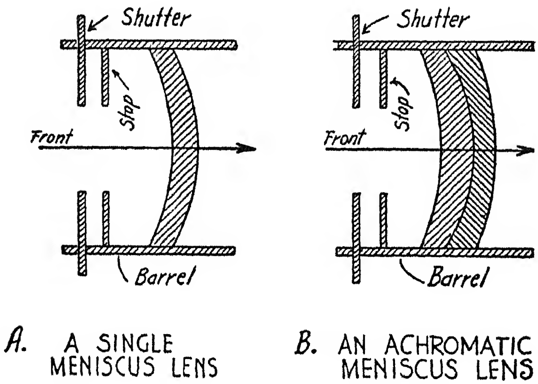


FIG. 22.—LENSES FOR FIXED-FOCUS CAMERAS

The Achromats, or Achromatic Lenses.—*The Single Achromat.*—As I have previously explained, an *achromat*, or *achromatic lens*, is one that is corrected for spherical aberration, and in its early form it consisted of a double convex lens made of crown glass and a plano-concave lens made of flint glass cemented together.

In *1857*, Grubb, an optical lens maker, of London, invented an achromatic lens that is formed of two concavo-convex lenses cemented together; the lens that is nearest the diaphragm being made of crown glass, and the other one being made of flint glass. Such a lens will give a sharp definition over a good-sized field with a fairly large stop and this is the kind of lens that is used at the present time in the better makes of fixed-focus cameras.

The Symmetrical, Rapid Rectilinear or Aplanat Achromat.—Since it is impossible to correct a single component for all of the defects an objective is heir to, the double component symmetrical objective was invented by Steinheil, of Germany, in *1866*. This objective consists of two symmetrical components, that is, two components which are just alike, placed at the right

focal distance apart in a tube with a diaphragm between them. With this lens the distortion effect is practically eliminated and, hence it made an ideal objective for taking architectural and mechanical photographs.

Moreover the combination of symmetrical components not only reduced the spherical but the chromatic aberration as well, hence a larger stop can be used and a higher speed can be had. For many years the three chief makes of this class of achromats were the *Steinheil Aplanat*,[6] the *Ross Symmetrical* and the *Dallmeyer Rectilinear,* the former so-called because the components were symmetrical, and the latter because the double components gave a straight line image.

The Aplanat-achromat Objective.—What is called the *aplanatic focus* of a lens is the point or focus from which the divergent light rays pass through a lens without spherical aberration. In some kinds of lenses there are two of these foci and advantage is taken of the neutralizing effects of one or the other. An *aplanatic objective,* or *aplanat,* consists of two components but instead of making each of them of a crown and a flint lens both were made of flint glass; the idea of this construction was so that the refractive indices[7] of the two symmetrical achromat components would be of a more nearly like value than where the usual crown and flint glass components were used. Steinheil, of Germany, brought out a whole series of them for various classes of work, the best known of which is the *Universal Aplanat.*

The Wide-angle Aplanat.—A *wide angle* lens is made with a pair of components exactly like the symmetrical or rapid rectilinear lens except that the lenses are of the aplanatic kind, *i.e.,* both lenses of each component are made of flint glass, they are curved considerably more, and the components are placed much closer together.

Nearly all wide-angle lenses are made on the aplanat principle, except the higher-priced ones which are of anastigmatic construc-

[6] From the Greek *a* which means *not* and *"plausitkos"* which means *wandering,* that is, *free from spherical aberration.*

[7] The *refractive index* is the number which expresses the ratio of the sine of the angle of incidence with the sine of the angle of refraction. It varies with the media through which the light passes and with the wave length of the light rays.

tion. These lenses are chiefly used for photographing straight line subjects in confined places, which is usually an interior, such as a room, or a building where the space is limited and a regular objective cannot be used.

The Soft-focus Lens.—This lens was originally devised by Dallmeyer to produce a focus diffusion, *i.e.*, a soft-focus effect. Different from a rectilinear lens, the soft-focus lens is not corrected for achromatism and, it follows, a sharp image cannot be had with it but it does give a soft and most pleasing effect when it is used by a pictorially minded photographer. It is formed of four single lenses with an air space between the components all of which have the same refractive index to give it the necessary amount of aberration. If you would like to try out the pictorial effects that a soft-focus lens gives you can do so by using a single lens of long focus or, better, a supplementary diffusion lens.

The Petzval Portrait Lens.—The real beginning of portrait photography was initiated by Joseph Petzval, a mathematician of Austria, in *1840*, who worked out a formula for a high-speed lens and this was constructed by Voightländer, of Austria. It was almost immediately improved upon by Andrew Ross, of England, who greatly increased its speed, then by J. H. Dallmeyer and later on by H. Zincke-Sommer, and nearly all of the portrait lenses at the present time are based on the original formula of Petzval.

His objective consists of two components, the front one being an achromat formed of a convex lens of crown glass cemented to a concave lens made of flint glass, while the rear component is formed of a concavo-convex lens of flint glass and a double convex lens of crown glass with an air-space between them.

The good features of this lens are that it is highly corrected for spherical and chromatic aberration, and coma, and it is free from distortion; oppositely, it is not corrected for astigmatism, covers a very limited field, and due to its length, there is a falling off of the intensity of the light rays as the edges of the plate or film are reached. These defects prevent it from being used for any kind of work except portraiture and for this purpose it is especially adapted.

The Copying and Enlarging Lens.—As its name indicates the purpose of this lens is to enable you to make a copy or an enlargement of a photograph or other picture. If you had a camera with a long enough bellows you could use an ordinary lens to make copies and enlargements with, but a lens that is made for the purpose can be used to better advantage.

A *copying* or *enlarging* lens consists of a pair of components each of which is formed of a convex and a concavo-convex lens. If you are only going to make a copy or an enlargement once in a while you can use a *supplementary copying* and *enlarging* lens, or *lens attachment* as it is also called, and this you place over the lens, provided it is a compound one, of your camera.

The Telephoto Lens.—This is a *long distance* lens, that is, it is used when you want to get a good-sized picture of an object which is a long way off, and to produce this result the lens is made on the principle of a telescope. The first telephoto lens was called the *Bis-Telar* and it was designed by Martin in *1895* for Emil Busch, of Germany. It consisted of a pair of components, each of which was formed of a double convex and a double concave lens. It had a relative aperture of *f.9* and a magnification of $1\frac{2}{3}$.

The Anastigmats, or Anastigmatic Lenses.—Until some *40* years ago all photographic lenses were made of crown and flint glass, and while these can be corrected for spherical and chromatic aberration and coma, they cannot be corrected for astigmatism. Oppositely, while the new lenses made of Jena barium glass can be corrected for astigmatism they cannot be corrected for spherical aberration.

To make a lens that is perfectly corrected for both spherical aberration and astigmatism Dr. E. von Hoegh, of Germany, worked out a formula for an objective whose components would be made of both the old and the new kinds of glass and which would then give the desired results. In some of the anastigmats, each of the components are formed of the old and the new kinds of glass while in others one of the components is formed of the old kind of glass and the other of the new kind of glass.

The anastigmat that was calculated by Dr. E. von Hoegh was first made by C. P. Goerz, of Germany, and it was the first

objective which would cover a plate or film, *i.e.*, form a sharp image on it from the center to the edges of it at a full aperture, without its being stopped down. The relative aperture of it is *f.6.8.*, and it is still being made and sold in this country under the trade name of *Dagor*.

Following came other anastigmats whose formulas were computed by various noted mathematicians and these were ground by the most celebrated lens makers abroad. Chief among the new anastigmats was the four-glass lens, or *Protar*, as it is called, and this was calculated by Dr. Paul Rudolph, of Germany, in *1900*, for Carl Zeiss, of Jena. The front component is formed of the old kind of glass and the rear component of the new kind of glass and its relative aperture is *f.7*.

In *1902* Dr. Rudolph calculated another and faster lens for the Zeiss Company and this is the now famous *Tessar*. It consists of three components, the first two of which are single lenses, and the third a double lens, and its relative aperture is *f.4.5*. The patents on it have expired and it is now made by different makers under various names as follows:

LENSES OF THE TESSAR TYPE

Aldis	Series I
Bausch and Lomb	Tessar
Ernemann	Ernon
Kodak	Anastigmat
Koristka	Sideran
Krauss	Trianar
Laack	Dialytar
Plaubel	Anticoma
Rüdersdorf	Acomar
Salmoirach	Phoebus
Schneider	Xenar
Tiranty	Transpar
Wollensak	Velostigmat

Note.—All of the above lenses have the relative aperture of *f.4.5*.

Following the introduction of the *Tessar f.4.5.*, new and faster formulas for the lens gave a relative aperture of *f.3.5.*, and one for moving pictures and other small cameras has a relative aperture of *f.2.7*. Then Zeiss produced the *Biotar* with the large relative aperture, and hence high speed of *f.2.*, and finally, the *Sonnar* of the exceptionally large relative aperture of *f.1.5*.

Some Typical Anastigmat Lenses.—*The Cooke Avair Lens*.—This lens is made by the *Taylor-Hobson Cooke Company*, of England, and it consists of four single lenses which are separated from each other, as shown in *Fig. 23*. The two front lenses are

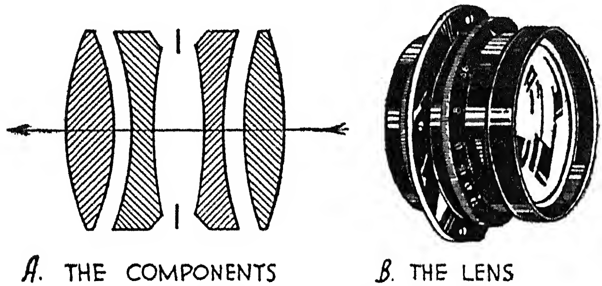


FIG. 23.—THE COOKE AVAIR LENS
(Series II; f.4.5.)

collective and the two rear ones dispersive. Throughout the range of its coverage it gives an exceedingly sharp definition. It has a relative aperture of *f.4.5.*, and is made in nine sizes, *i.e.*, for plates or films from $2\frac{1}{4} \times 3\frac{1}{4}$ to 8×10, and which are covered at full aperture. The Avair lens can be used on all ordinary hand cameras and also for aerial photography, while the larger sizes are excellent for both view and portrait work.

The Goerz Dagor Lens.—This lens was formerly made by C. P. Goerz,[8] of Germany, and it consists of two like components each of which is formed of three lenses as shown in *Fig. 24*. It is very accurately corrected for both spherical and astigmatic aberration and has a relative aperture of *f.6.8*. It gives a definition at large apertures equal to that of any other lens and it will produce straight lines with the smallest stops, and an image circle of nearly *90* degrees thus making it an excellent lens for taking architectural and commercial pictures and also for copying and enlarging. It is sufficiently fast to take sport pictures with and of rapidly moving objects, where they are properly lighted, with a focal-plane shutter camera.

[8] When C. P. Goerz, of Berlin, joined Carl Zeiss, of Jena, in *1926*, certain lenses of the original Goerz formulas were continued by the latter.

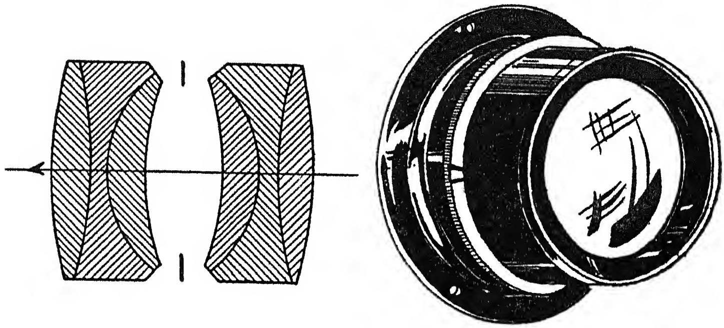


FIG. 24.—THE GOERZ DAGOR LENS
(Relative aperture [speed] f.6.8.)

The Rudolph-Goerz Protar Lens.—The original *Protar* lens was calculated by Rudolph in *1890*, and it consisted of a pair of unsymmetrical components, each of which was formed of two single lenses. One of the components was made of the old kind of glass and this was spherically corrected, while the other was formed of the newer Jena glass and this was astigmatically corrected.

The Protar was first made by C. P. Goerz, of Berlin, and when this firm combined with Carl Zeiss, of Jena, they continued to make it for some years, but it has now given way to the Goerz *Dagor*. At the present time it is manufactured by *Bausch and Lomb*, of Rochester, New York, and it is made in two series, *Series VII* and *Series VIIa*.

The *Protar Series VII* consists of a single component and this is formed of four lenses. When two *Series VII Protars* are used in combination they make what is called a *VIIa Protar*, which is shown in *Fig. 25*. With this lens you can use either (*a*) both components, (*b*) the rear component or (*c*) the front component. The purpose of doing so is to enable you to get different-sized images at the same distance from the subject you are taking the picture of.

Thus by using both components you get a small image, by using the back component you get a larger image, and by using

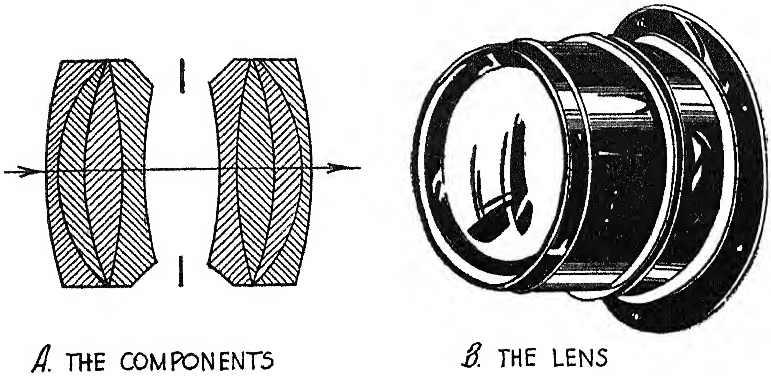


FIG. 25.—THE RUDOLPH-GOERZ SERIES VIIA PROTAR LENS
(Made by Bausch and Lomb. Relative aperture [speed]: double, f.6.3; single, f.7.7.)

the front component you get a still larger image. The speed of the lens with both components is *f.6.3.*, and when either one is used singly it is *f.7.7.* You can get three or more *Series VII* components which can be used interchangeably in the barrel mount or shutter and these make up what is called a *Convertible Protar.*

The Goerz Wide-angle Dagor Lens.—This lens, which is made by Carl Zeiss, Jena, is like the Goerz *Dagor* which I have previously explained in that it has a pair of symmetrical anastigmat lenses and each one consists of three components cemented together. Like the *Dagor* it is fully corrected for chromatic and spherical aberration and for astigmatism, and it gives a perfectly flat field. It will include an angle of *100* degrees and yet has the relative high speed of *f.9* which makes it easy to focus on the ground-glass screen and for instantaneous exposures. It is largely used for interiors, architectural work, close commercial work, such as taking machinery, panoramic views, copying and enlarging, for banquet flash-lights, etc.

The Goerz Extreme Wide-angle Hypergon Lens.—The *Hypergon* lens was calculated by von Hoegh, of Germany, in *1900,* for C. P. Goerz and it is now made by Carl Zeiss, Jena. It will cover a flat anastigmat field of *140* degrees. The focusing stop is *f.22*

and aberration is eliminated by using an *f.32* stop when taking the picture, while the correction for astigmatism is had by using very thin lenses.

The *Hypergon,* which is shown in *Fig. 26,* is a symmetrical lens and it consists of two single hemispherical components, whose angle is so wide (*140* degrees) that it forms an image about five times its own focal length, *i.e.*, a *Hypergon*[9] with a $4\frac{3}{4}$-inch focal length will cover a *12 x 16*-inch plate or film at full aperture,

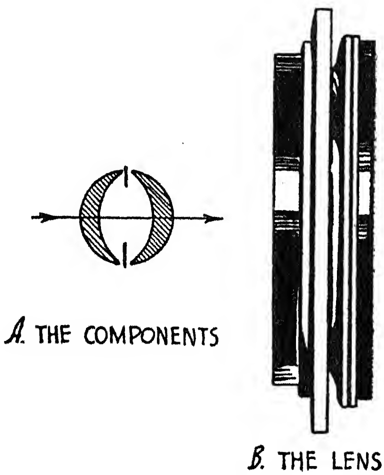


FIG. 26.—THE VON HOEGH-GOERZ HYPERGON EXTREME WIDE-ANGLE LENS

(Made by Carl Zeiss, Jena. Includes a 140-degree angle. Relative aperture [speed] f.22.)

and a *16 x 20*-inch one when it is stopped down to *f.32*. It is used for taking interiors, architectural pictures, panoramic views, and so on.

The Rudolph Zeiss Tessar Lens.—The *Carl Zeiss Company,* of Germany and the United States, make several modified forms of the original Rudolph *Tessar* lens. All of them, however, follow the same simple construction and as they are very accurately

[9] The word *hypergon* is compounded from the Greek *hyper* which means *over or above* and *gonia* meaning *angle.*

corrected they are typical of the finest and fastest photographic lenses that are made at the present time.

The Tessar consists of three components, the first two of which are single lenses and the third a double lens, as pictured in *Fig. 27*. The *Tessar f.4.5* is largely used for hand cameras, and the *f.3.5*, *f.2.8* and *f.2.* for miniature cameras. The *f.3.5* is especially suitable for taking landscapes, portraits, street scenes, sport events—in a word all kinds of every day subjects. This lens seldom needs to be stopped down and it can be advantageously used as an enlarging lens. The *f.2.8* will pass *50* per cent more

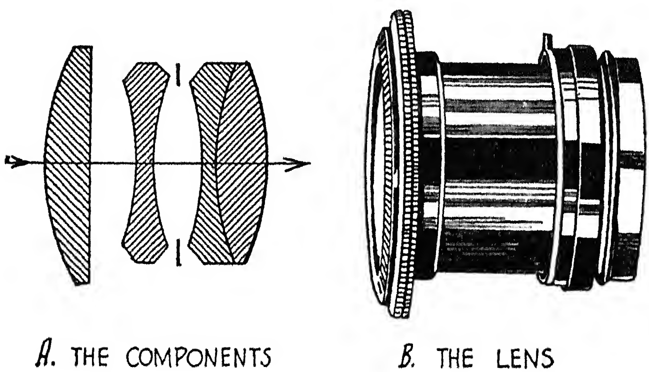


FIG. 27.—RUDOLPH ZEISS TESSAR LENS
(Relative aperture [speed] f.3.5; 2-inch focus.)

light than the *f.3.5* and its greater speed adds to the scope of work it will do. It is particularly adapted for color photography.

The Zeiss Biotar Lens.—This is a four-component lens, the front one being a single concavo-convex meniscus, the second a plano-convex and plano-concave, the third, a double concave and a double convex, and the fourth a double convex lens as shown in *Fig. 28*. It combines the large aperture of *f.2* with the short focal length of $1\frac{9}{16}$ inches, and the angle of view is *55* degrees—*10* degrees greater than that of the above *f.3.5* lens. It is, therefore, an ultra-high speed universal lens for miniature cameras that gives a very wide angle of view.

Notwithstanding its exceedingly large aperture and coverage its definition is remarkably good and it is widely used for taking press photographs, theatre snap-shots, and other pictures where the light is weak and the exposures must be short. The *Biotar* cannot be connected with the range finder and so automatically focused with it, but it is focused by means of an external quick-action bayonet mount.

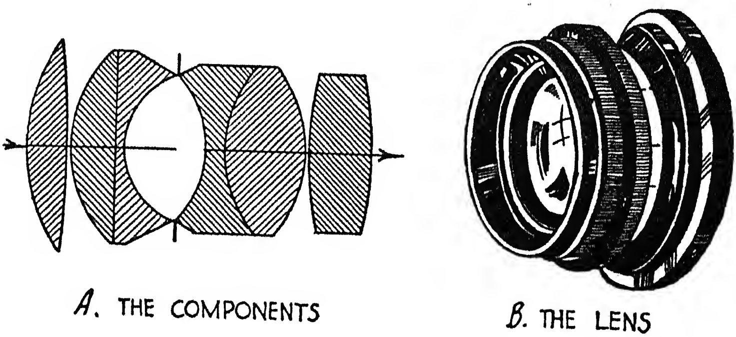


FIG. 28.—THE ZEISS BIOTAR LENS

(Relative aperture [speed] f.2; 1 9/16-inch focus.)

The Zeiss Sonnar Lens.—The last word in large aperture lenses is the ultra-fast *Sonnar f.1.5* lens with a 2-inch focus, which is shown in *Fig. 29,* and it is 5½ times as fast as the *Tessar f.3.5* lens with a 2-inch focus. At full aperture it gives an image

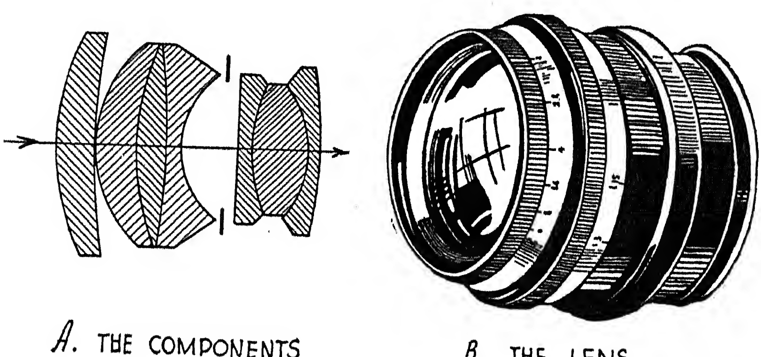


FIG. 29.—THE ZEISS SONNAR LENS

(Relative aperture f.1.5; 2-inch focus.)

that is as sharp and as evenly illuminated at the center of the film as it is at the margins. It has opened up an entirely new field of photography—candid snap-shots under all kinds of lighting conditions and, it follows, it is a good lens to use for taking indoor pictures where short exposures are necessary.

The Telephoto Anastigmat Lens.—There are several makes of anastigmat lenses on the market and chief among these are the *Booth Teleobjective,* the *Cooke Telekinic* and the *Lee Telephoto* lenses of *Taylor-Hobson, Cooke Company;* the *Dallmeyer Adon;* the *Radiar* of the *Gundlach-Manhattan Company;* the *Telecentric* and *Teleros,* of *Ross, Limited,* England; the *Tele-Dynar* of *Voightländer;* the *Telyt* of *E. Leitz, Incorporated,* and the *Tele-Tessar* of *Carl Zeiss Company.* The relative apertures of the above lenses range from *f.6.8* to *f.3.3* and the magnification-ratio from *2* to *3* times. I can't go into the details of all of the above telephoto lenses but will describe the *Tele-Tessar* of Zeiss, as a typical objective of this kind.

The Zeiss Tele-Tessar Lens.—As *Fig. 30* shows this objective has three components, the front one of which is a double convex lens, then a double concave lens that is separated from it by an air-space and the rear one formed of a pair of cemented meniscus lenses. This telephoto lens has the longest focus of all of those made for use with the *Contax* camera that can be coupled with the range finder.

It *brings up* the most distant objects in full detail just as you see them in a field-glass. As it is not easy to hold a camera that is fitted with a telephoto lens steady enough in your hands when making shots of moving objects, it is the better way to mount it on a tripod.

In taking pictures of wild animals in their natural habitat, or of birds at a distance of a mile or so, a lens having a longer focal length than the *Tele-Tessar, i.e., 7½* inches, must be used, and so a *special long-focus telephoto* lens that has an aperture of *f.8.* and a focal length of *12* or *20* inches is made. It can be attached to a miniature camera, or to a *focusing screen adapter* instead of the camera. A *Zeiss Tele-Lens* secured to a focusing screen adapter is pictured in *Fig. 31.*

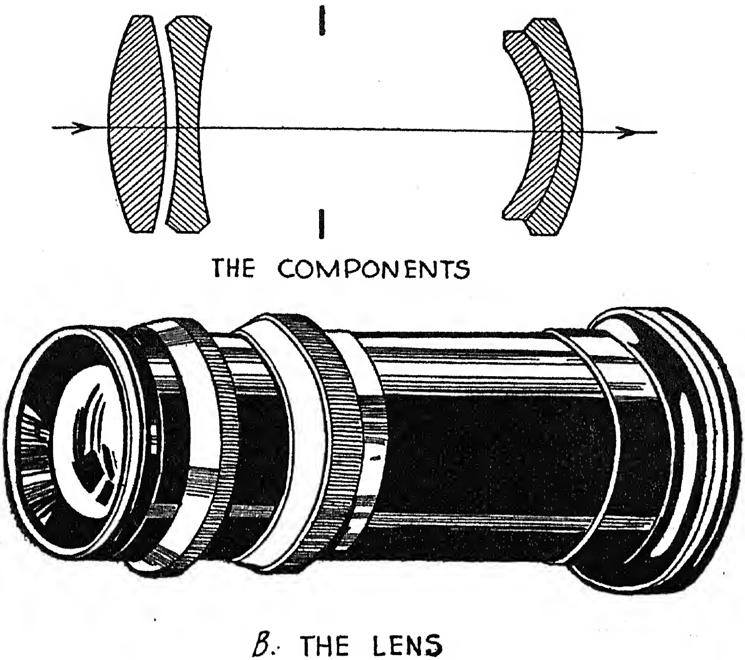


Fig. 30.—The Zeiss Tele-Tessar Lens

(Relative aperture f.6.3; 7½-inch focal length; magnification ratio 2 times.)

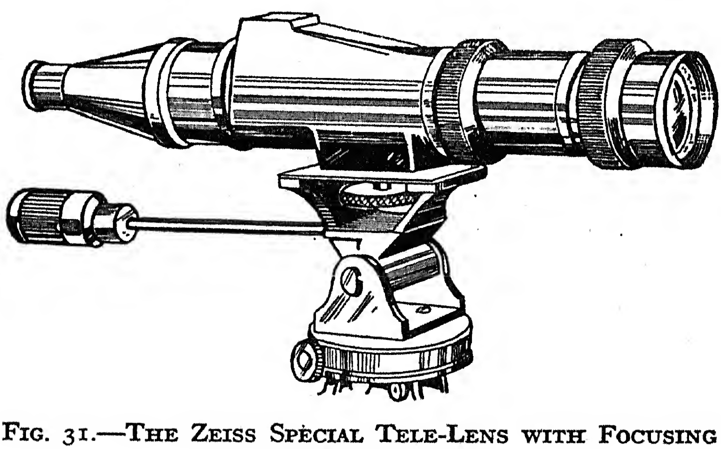


Fig. 31.—The Zeiss Special Tele-Lens with Focusing Screen Adapter

III. SUPPLEMENTARY LENSES AND DIFFUSION DISKS

A *supplementary lens*, or *lens attachment* as it is also called, is one that you can slip on the front of a regular lens and convert it into any kind of a lens you want, *i.e.*, (*1*) a portrait lens, (*2*) a wide-angle lens, (*3*) a soft-focus lens, (*4*) a copying and enlarging lens, or (*5*) a telephoto lens. Each of these supplementary lenses is mounted on a brass collar or *holder*, as it is called, so that it can be slipped on the front end of the barrel of the regular lens.

The *supplementary portrait* lens enables you to take close-ups of persons as well as clear-cut, close-range pictures of flowers and small objects in general. It keeps the focus sharp at close range and forms images that are nearly as large as the plate or film itself.

The *supplementary wide-angle* lens is, as its name indicates, used for increasing the angle of the view and it is not only useful for taking wide-angle interior and street scenes, but also for taking magnified pictures of small objects. You can get a supplementary lens of this kind that will increase the angle of view by *17* or *23* per cent, and one or the other will serve all of your ordinary needs.

The *supplementary soft-focus* lens or, more properly, *diffusion disk*, for it is really not a lens but a disk of plane glass that has concentric circles polished in the surface of it, is used to diffuse the light rays before they pass through the regular lens, and this gives the image a pleasing softness that is termed a *soft-focus effect*.

Now there are two kinds of diffusion disks and these are (*1*) the pictorial diffusion and (*2*) the portrait diffusion disk. The *pictorial diffusion disk* is used for giving what artists call *atmosphere* to a landscape, while the *portrait diffusion disk* is for reducing sharp contrasts, blending harsh lines and giving a charming softness to close-up portraits, and this without any loss in the brilliancy of the picture.

The *supplementary copying and enlarging lens* is of about the same order as the supplementary portrait lens. When the lens is used with the ordinary one on your camera you can take a picture

of another one that is of the same size, when it is called a *copy,* or one of a larger size when it is called an *enlargement,* and this you do by the simple expedient of placing the picture you are copying or enlarging farther away or closer to the lens.

The *supplementary telephoto lens* increases the focal length of the regular lens in the same way that the supplementary copying and enlarging lens reduces it and the result of it is a magnification of the distant image. The supplementary telephoto lens, by virtue of increasing the focal length of the regular lens, causes a corresponding reduction of the angle of view, and the definition will not be as sharp as that of a telephoto lens because it adds to the aberration of the regular lens you use on your camera, hence the image will have a more or less soft-focus effect.

IV. LIGHT FILTERS AND THEIR USES

A *light filter, color filter,* or *ray filter,* as it is variously called is, simply, a disk of colored glass, or a dyed gelatin film, that absorbs rays of different wave lengths and lets other wave lengths from the object you are taking the picture of pass freely through it. A filter of whatever kind is mounted in a brass ring that can be slipped over the front of the lens barrel. The purpose of using a light filter is primarily to (*1*) enhance the beauty of the picture you are taking, and (*2*) to give a true rending of the color values of it, that is, as the eye sees it, when taking a picture of a colored object, and this is called *orthochromatic photography.*

Light filters are made in six colors and these are (*a*) *red* which absorbs blue and green light; (*b*) *green* which absorbs blue and green light; (*c*) *purple* or *magenta* which absorbs green light; (*d*) *light blue* or *blue-green* which absorbs red light; (*e*) *dark blue* which absorbs green and red light; and, lastly, (*f*) *yellow* which absorbs blue light. I can't go into all the varied uses of these different filters here, but what I shall do is to tell you about two of the chief ones that are used by the everyday amateur, and named these are (*a*) the yellow filter, and (*b*) the sky filter.

The *ordinary yellow filter* absorbs practically all of the ultra-violet, violet, and the blue rays, and lets the green, orange, and red rays pass freely through it. It is of great value when you are

taking pictures of landscapes, flowers, art objects, and other things that have considerable color in them. Thus it holds back some of the blue light of the sky and so lets the white clouds stand out against the gray of it; it brings out the fine details of the high-lights and shadows in water and snow scenes, and makes flowers stand out light against the foliage.

The resultant black and white image that you get on the negative and, it follows, in the print, renders the value of the colors of the scene or object that you photographed far more correctly, *i.e.*, as the eye sees them, and at the same time retains much of the brilliancy which would otherwise be lost.

What is called a *sky filter* is one in which only the lower half of the glass or gelatin disk is colored yellow and, like the one described above, it cuts off the ultra-violet, violet, and blue rays but only from the sky. Since this is the way of it the clouds are brought out beautifully clear, while all of the rays from the landscape pass freely through the upper part of filter and lens, and, hence, the final picture is a very brilliant one.

The *polarization filter, polaroid filter* or *pola-screen,* as it is variously called, is the latest one on the market, and it has the peculiar property of (*1*) polarizing the light that passes through it and the lens, and (*2*) controlling the intensity of the light which has already been polarized. The chief use of the polarization filter is to (*a*) eliminate oblique reflections and (*b*) to filter variable depth dark-sky effects.

The filter is made of a sheet of material whose trade-name is *polaroid,* and this, in turn, is formed of cellulose acetate ($C_6H_7O_2(OCOCH_3)_3$) (which is very like cellophane), and it has an infinite number of exceedingly minute needle-like crystals embedded in it so that all of them lie in parallel lines to each other. The result is that it transmits about *40* per cent of the polarized light and absorbs the other components.

The *Eastman pola-screen* consists of a disk of polaroid cemented between a pair of optical glass plates and these are mounted in a metal ring. The filter thus formed is placed on the lens hood when it is ready for use. How light is polarized, the effects of it when used in photography, and a fuller description of the pola-screen is given in a booklet called *Photography by*

Polarized Light, published by the Eastman Kodak Company, Rochester, New York. You can get a copy of it for the asking.

How to Care for Lenses and Filters.—*About Cleaning Lenses.*—To take sharp and brilliant pictures the lens must be perfectly clean, *i.e.*, free from dust, fingermarks and smoke deposit. Now the first thing to do in order to clean the components of a lens is to take them out of their mount one at a time so that you will not have to lay them down. Lenses are made of optical glass and this is considerably softer than ordinary glass, and, hence, in cleaning them you must be scrupulously careful not to injure their surfaces.

The two chief kinds of injuries that are caused by careless cleaning are (*a*) abrasions and (*b*) roughness. To prevent abrasions remove the dust that is on the lens with a camels hair brush,[10] then moisten it (the lens) with a little water or alcohol and rub it dry with a very soft old linen handkerchief. If the lens is a cemented one and you use alcohol be very careful that none of it gets on the edge for it might dissolve the Canada balsam.[11]

Never, under any circumstances, use chalk, rouge or any kind of cleaning powder or polishing paste on the lens or you will surely ruin it. Again, do not use soapy water or any kind of a solution that has either an alkali or an acid in it for cleaning the lens for these compounds will react with the elements of which the glass is made and so roughen the surface of it. Whenever you take the components out of the lens mount wipe the inside of it with a soft linen cloth.

Care of Light Filters.—Light filters that are made of glass should be cleaned in the same way that I described above for lenses. If they are made of gelatin and are not mounted between glass disks you must protect them from heat and moisture when they are not in use by keeping them between the leaves of a notebook. When handling them always hold them by their edges, or, better, with tissue paper.

Where gelatin filters are mounted between glass disks they are

[10] This should be washed occasionally in alcohol, wrapped in filter paper, hung up to dry and then kept in a dust-proof case.

[11] Canada balsam is a yellow, viscid liquid that is obtained from the balsam fir.

usually cemented on both sides to the latter, with Canada balsam, and when they are not in use you should keep them in a case in order to prevent the light from acting on the dyes that they are colored with, and which will in the course of time change their absorptive powers. When cleaning gelatin filters that are placed between glass disks be very careful that the water does not come in contact with the edges of them for this will cause them to swell up, and so result in deformation. If you use alcohol, the same precautions are necessary for this may act on the dyes and so reduce their absorptive powers.

CHAPTER IV

THE USE OF DIAPHRAGMS OR STOPS

WHAT is called the aperture[1] of a lens is the exposed, or effective part of it through which the light rays from the object that is being photographed pass and form the image on the screen, plate or film. Now, as you have seen in the preceding chapter, lenses of whatever kind have numerous defects and even when they are combined to form components and these in turn to form objectives, and they are corrected, in so far as it is humanly possible to do so, when the lens is used with a *full* aperture the image that is formed by it will not be perfect.

The chief way to reduce these defects to a minimum is to place a *diaphragm,* or *stop* as it is commonly called, either before the lens if it is a single component, or between the components if it is formed of a pair of them. And now let's find out just (*1*) what a diaphragm or stop is, (*2*) what it does when it is used, (*3*) what the letter mark and number on it means, and, lastly, (*4*) the kinds that are used.

What a Diaphragm or Stop Is.—In its simplest form a diaphragm or stop consists of a piece of sheet-metal with a circular hole, opening, or *aperture,* as it is also called, that is smaller than the lens, cut in the center of it. In the early lenses it was fixed in the barrel before the components of them but at the present time it is so used only in the cheapest little cameras.

Why a Stop Is Used.—There are three chief reasons why a stop can be used to advantage when you are taking a picture with a lens of any kind and these are (*1*) it makes the image sharper, (*2*) it improves the detail, and (*3*) it gives a greater depth of focus. The great disadvantage of using a stop is that it cuts off the light rays which pass through the margin of the lens and, it

[1] From the Latin word *apertura* which means *open.*

follows, the smaller the stop, *i.e.*, the aperture of it, the longer the time of exposure will have to be.

It is obvious now that when a lens is stopped down the only effective rays are those that pass through the center of it and as this part is less defective than the marginal part of it the result will, perforce, be a sharper image. Since the defects of any kind of a lens, except an anastigmat, is so pronounced when it is used with its full aperture, that is, without a stop, the details of an image formed by it will not be uniformly sharp; it follows, then, that the only way to improve it is to use a stop, and the smaller it is the sharper it will be and, again, the longer the required exposure.

What is called *depth of focus* means the degree to which the image of objects at different distances will be sharp and this depends on no less than five factors; named these are (*1*) the focal length of the lens, (*2*) the size of the aperture of it, (*3*) the distance of the object that is in sharp focus, (*4*) the diameter of the circles of confusion, and (*5*) the amount of spherical aberration.

Ordinarily the shorter the *focal length* of the lens, the greater its depth of focus will be, and the *smaller the aperture,* which decreases the speed of the lens, the greater the depth of focus. The *nearer the object* that is in sharp focus the more obvious will be the difference in the depth of focus when stops of various apertures are used.

What are called *circles of confusion* are light rays which instead of focusing as sharp points form, instead, minute circles of light, and the larger the aperture of the lens the more sharply are they defined. Usually circles of confusion are not apparent to the eye because the definition of the latter is limited and, hence, it cannot recognize critical sharpness.

Finally, *spherical aberration* kills critical definition since the apparent depth of focus is increased by it, and there is no clear line of demarkation between the part of the image which is sharply defined and that part of it which is not sharply defined. When an anastigmat lens is used the image formed by it is not subjected to the untoward features which affect the depth of focus, or, at least, not nearly as much as the achromat and, hence, it can be used with a larger stop and usually with a full aperture.

Systems of Stop Notation.—*What the Letters Mean.*—On the stop of every good lens you will find the lower case italic *f*, or the Roman upper case letter *F*, or the letters *U.S.*, and after the letter or letters there is a number and these are separated by a diagonal line, a semicolon, or a period, thus: *f/4, f:5.6, f.8,* etc. All of these letters mean one and the same thing and that is the *focal length* of the lens, while the diagonal line, semicolon, or period shows that the number which follows it is a *fraction* and not a whole one as it is written.

What the Numbers Mean.—The number after the diagonal line, semicolon, or period shows the numerical relation between the diameter of the aperture in the stop and the focal length of the lens. Now you will remember that the focal length is the distance from the longitudinal center of the lens to the point where the rays that pass through it converge and meet each other. From the very beginning of photography it was well known that when a lens is stopped down it would give a sharper image, and that the smaller the aperture in it the longer the exposure had to be.

But what the early makers of lenses did not know was that there is a definite relation between the focal length and the aperture in the stop. So stops were made with various-sized apertures in them and the photographer used the one he *guessed* would give the sharpest image for the length of time he wanted the exposure to be. In other words he had to arbitrarily strike a rough balance between the sharpness of the image he wanted and the time of exposure he had to give it.

Later on it was mathematically shown that the aperture of a stop was in proportion to the focal length of the lens and, hence, the time of exposure likewise was a definite element of the product; thus $\frac{d}{f} = t$, where d is the diameter of the aperture of the stop, f is the focal length of the lens and t is the time of exposure. And so it came about that the aperture, or *size of the stop,* as it is commonly called, or the full aperture of the lens, *i.e.*, its diameter where it can be used without a stop, as in the case of an anastigmat, is used as an arbitrary measure of the *speed of a lens.*

The Effect of the Intensity of Light.—Now although the intensity of the light rays is a large factor in determining the time of exposure, the makers of lenses do not mark them according to the brightness of the image they form but, as you have seen above, according to the relative time required for the exposure which, in the last analysis, amounts to the same thing, since it is in inverse proportion to the intensity; to put it a little more simply as the brightness of the image is increased the time of exposure is proportionately decreased.

The f or F System of Stop Notation.—The system of *f* or *F* notation was devised by a committee of the *Royal Photographic Society of Great Britain* in *1881* who adopted an aperture of *1:4*, that is as *1* is to *4*, as a standard. A sequence of aperture ratios were selected whereby each successive aperture has an area that is ½ of the one before it, hence each successive aperture is twice that of the one before it.

By this system the time of exposure that is necessary for each successive stop is double that of the one before it. Since this is the way of it the series of ratios of the stops are equal to:

$$\frac{1}{4} \quad \frac{1}{5.6} \quad \frac{1}{8} \quad \frac{1}{11.3} \quad \frac{1}{16} \quad \frac{1}{22.6} \quad \frac{1}{32} \quad \frac{1}{45} \quad \frac{1}{64}$$

Instead of being marked in fractions, however, as given above, they are simply marked as whole numbers thus:

f or *F* *4* *5.6* *8* *11.3* *16* *22.6* *32* *45* *64*

The ratio of exposures required by the above stops are:

1 *2* *4* *8* *16* *32* *64* *128* *256*

From this you will observe that it takes 256 times the intensity of light rays to make an exposure with an *f.64* stop as it does with an *f.4* stop.

The U.S. System of Stop Notation.—In this case *U.S.* doesn't stand for United States or your Uncle Sam but for *Uniform System*, and it was devised to make the series of stops run uniformly in geometrical progression; thus the largest one is numbered *1*, the next smaller one is *2*, the third one is *4* and so on until the

smallest stop is reached which is *256*. The *U.S.* system of notation is not now used but I am including it because some of the older makes of lenses are so marked, and, hence, you should know about it.

Since the largest opening in the *U.S.* stop is *1* this lets through the greatest number of light rays; the next sized stop is *2* and this lets only half as many rays pass through it as the *1* stop. The next stop is *4* and this lets only one-fourth as many rays through it as the *2* stop. In other words the sizes of the apertures of the stops are so proportioned that the number of rays which pass through them follows the law of inverse squares; it follows, then, that if you know what the time of exposure is with one stop you will know what it will be for any other stop.

The following table gives the equivalent sizes of *f* or *F* and *U.S.* stops:

TABLE OF EQUIVALENT STOPS AND TIME OF EXPOSURE

f OR F STOPS	EQUAL	U.S. STOPS	TIME IN SECONDS IN SUNSHINE
4	"	*1*	1/400
4.5	"		
5	"		
5.6	"	*2*	1/200
6.3	"		
6.8	"		
7.5	"		
8	"	*4*	1/100
11.3	"	*8*	1/50
16	"	*16*	1/25
22	"	*32*	1/12 (use 1/10)
32	"	*64*	1/6 (use 1/5)
45.2	"	*128*	
64	"	*256*	

The Speed of Lenses.—You will have gathered that the term *speed of a lens* means the largest aperture of a stop that can be used with it and, hence, the shortest time of exposure that can be made with it. As an illustration the speed of a *single meniscus lens,* that is used on the cheapest box cameras is *f.32*, which means that this is the largest stop that can be used with it, and, consequently, the shortest exposure you can give a plate or a film of ordinary sensitivity is $\frac{1}{10}$ of a second in the sunlight, though the shutters are timed to $1/25$ of a second.

A *single component achromatic meniscus lens,* which is formed of two lenses cemented together, that is used in the better box cameras have a speed of *f.16,* and this means that you give a plate or a film an exposure of $1/25$ of a second. The *double component achromatic lens* which is used in small folding cameras, has a speed of *f.11.3* and, hence, an exposure of $1/50$ of a second can be made with it. The better kind of achromats have stops of from *f.8* to *f.6.3,* and they have speeds of $1/100$ of a second and better.

Satisfactory pictures cannot be made with achromats that have a larger stop than *f.6.3* and it follows that if you want a higher speed than this you must use an anastigmat lens. An anastigmat having an *f.5* aperture will give you a speed of $1/200$ of a second with an ordinary dry plate or film; one that has an *f.4* aperture, a speed of $1/400$ of a second, and an *f.2* a speed of $1/800$ of a second. With the new fast plates and films that are now made the speed values of the above lenses are increased several fold.

Kinds of Stops.—There are only three kinds of stops used at the present time and named these are (*1*) the fixed stop, (*2*) the sliding stop and (*3*) the iris diaphragm or variable stop.

The Fixed Stop.—As I mentioned in the early part of this chapter the *fixed stop* consists simply of a ring cut out of thin sheet-metal, and this has a hole in it that is a little smaller than the aperture of the lens it is to be used with, as shown at *A* in *Fig. 32*. It is fixed in the barrel in front of the lens and is used in only the cheapest kinds of little fixed-focus cameras.

The Sliding Stop.—This kind of a stop is made of a strip of thin sheet-metal and it has either two or three holes, or apertures, of different diameters cut in it in a line as pictured at *B*. The strip slides in a pair of grooves in front of the lens and it is

the kind that is in general use on the better makes of box cameras as, for example, the *Brownies.*

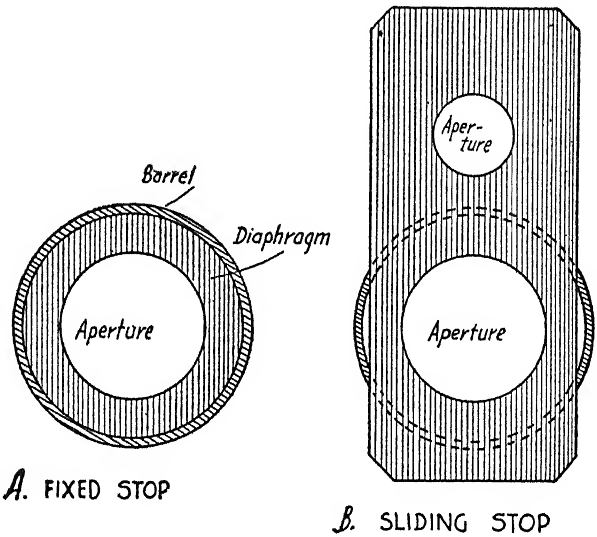


FIG. 32.—SIMPLE DIAPHRAGMS OF STOPS

The Iris Diaphragm or Variable Stop.—This stop is formed of a number of curved leaves that are punched out of thin sheet-metal. These leaves, of which there are usually ten or a dozen, overlap each other and when they are brought together only a very small circular hole or aperture is left open; oppositely when they are spread out a larger circular aperture is formed, the size of it varying according to the amount they are moved forth toward the center of the lens, or back toward the rings to which they are attached.

When you watch the leaves of an iris diaphragm as they close and open so smoothly and with such precision you would be justified in concluding that they could do so only by means of a complex mechanism of some kind. But not so for there are no mechanical contrivances of any kind that are connected with the leaves.

Now there are different schemes that are used by the various makers for closing and opening the leaves of the iris stop, but

one of the simplest is formed of ten or a dozen leaves, one of which is shown at *A* in *Fig. 33,* and two thin flat metal rings as at *B* and *C*. You will observe that in the smaller end of each leaf

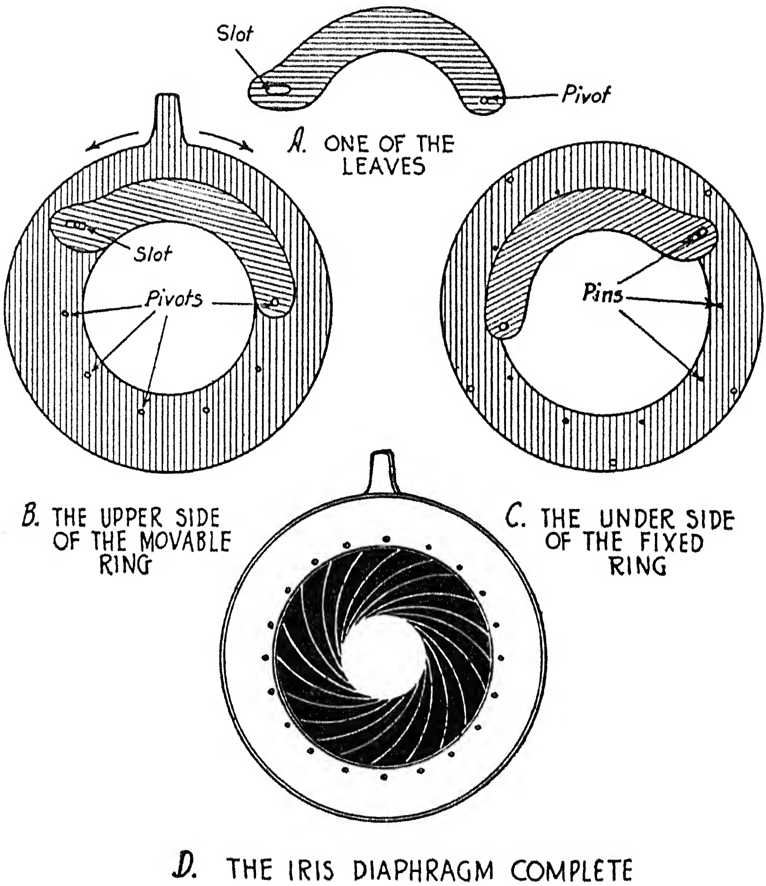


FIG. 33.—HOW THE IRIS DIAPHRAGM IS MADE AND HOW IT WORKS

there is a minute hole, while in the other and larger end there is a little slot.

One of the rings is fixed to a flange of the barrel of the lens, and the other is free to turn through an arc. The smaller ends of the leaves are pivoted to the fixed ring at equidistant points

around it, while the slotted ends of them are slipped over a like number of pins that are secured to the inner circumference of the fixed ring. The movable ring has a bar attached to it which extends through a slot in the flange of the barrel to the outside of the latter, so that you can move it through the arc with your fingers.

The movable ring with the leaves pivoted to it is then placed in the flange and the fixed ring is laid on top of it and screwed to it. Now when you want the stop to have a small aperture you push the bar toward the right which slides the leaves over each other, and, conversely, when you want a larger aperture you push the bar toward the left. An iris diaphragm is pictured at *D*.

CHAPTER V

HOW SHUTTERS ARE MADE AND HOW THEY WORK

In the early days of photography the sensitized plates were very slow and they were exposed in the camera by the simple expedient of removing the cap from the lens, holding it in the hand for the required interval of time and then putting it back on again. When, however, faster plates and better lenses were made it became necessary to use a quicker and more accurate means for opening and closing the lens and so the *shutter* was invented.

The Development of the Shutter.—*The Drop Shutter.*—The first shutter was invented by Fizeau and Foucault, of France, in *1845,* who used it for taking photographs of the sun, but it was not employed for ordinary photographic work until about *10* years later when the wet collodion plate was introduced.

The Fizeau-Foucault shutter was of the *simple drop,* or *guillotine type* as it was called, and it consisted of a thin wooden slide with an opening in it, and this slipped into the grooves of a thin piece of wood that had a circular hole in it. It was then mounted on the hood of the lens in a vertical position, and when the plate was to be exposed the slide was released by hand and so dropped down, when the opening in it passed over the aperture of the lens.

In *1862* Jamin, of France, improved upon the drop shutter by making the slide of sheet-metal that had an opening in it; this passed through a pair of slots in the barrel between the lenses, and he greatly increased the speed of it by means of a rubber band. A further improvement was made in it by the present author in *1888* by connecting one end of the metal slide with a piston that moved in a long thin brass cylinder which was secured to the top of the lens barrel. One end of a thin rubber tube was connected with the small end of the cylinder while the other end had a rubber bulb attached to it.

Now when an exposure was to be made the bulb was given a

quick, strong pressure and the compressed air drove the piston to the other end of the cylinder when the opening in the slide shot across the aperture of the lens. What the time interval of the exposure was it would be hard to say but photographs were taken with it that showed the storm waves of Lake Michigan breaking on the pile-driven shore in which separate drops of water could be seen, and it was, therefore probably in the neighborhood of $1/50$ of a second.

The Rotary Shutter.—In *1858* the *rotary shutter,* a modified form of the drop shutter, was devised, and this consisted of the sector of a circle pivoted at its radial center and which had an opening cut in it. Bertsch, of Germany, and Lancaster, of England, both made improved forms of it, and the rotary shutter that is now used in fixed-focus cameras, and the single plate opaque sector shutter that makes an exposure at every complete revolution which is used in moving-picture cameras and projectors are modified forms of it.

The Double-leaf Shutter.—This is a distant relative of the drop shutter and it was invented by Mann, of England, in *1862,* and greatly improved upon by Decaux, of France, in *1873.* It was formed of a pair of sheet-metal leaves one end of each one of which was pivoted to one end of a pivoted lever, and these were made to slide in a horizontal plane by means of pins that set in slots of them. The lever was moved by a sector fixed to a pinion and this meshed with a rack which was connected with a piston in a cylinder, and back of it was a coiled spring. One end of a rubber tube was attached to the end of the cylinder and a rubber bulb to the free end of it.

Now when an exposure was to be made the rubber bulb was pressed and the air in the cylinder forced the piston to the other end of it; this caused the rack and pinion to turn the sector and this, in turn, pushed the lever over and so opened the leaves. When the pressure on the bulb was relaxed the compressed spring forced the piston back and so closed the shutter. This is the first shutter that I know of which used compressed air to work it.

A modification of the two-leaf shutter was devised by Packard of the United States about *1880,* and it is still used in an improved form by studio photographers. In its original form it

consisted of a pair of leaves and each of these was pivoted at its lower end. The leaves were connected with a lever and this was pivoted to a piston in a cylinder, while a bulb and rubber tube was fitted to the small end of the latter. Now when an exposure was to be made the bulb was pressed and the air forced the piston to the other end of the cylinder, and when the pressure was relaxed the suction forced it back again and so closed the leaves.

The Multiple Leaf, Inter-lens, or Between-the-lens Shutter.—This shutter was devised by Beauchamp, of France, and Dallmeyer, of England, in *1887*. It was formed of three leaves and these were pivoted at equidistant points to a pair of rings. When one of these was turned a little the leaves slipped simultaneously over each other and so opened and closed the aperture of the lens. This shutter was improved upon by Deckel, of Germany, in *1905*, and this was the forerunner of the *Compound* and the *Compur* shutters of the present time, and which are made by the *Bausch and Lomb Optical Company*, Rochester, New York.

Deckel's shutter consisted of a pair of thin metal rings, an *external* one that was fixed to the barrel of the lens, and an *internal* one which turned round on it. The leaves, of which there were three, four, or five, were pivoted at equidistant points to both the fixed and the movable rings as shown at *A* and *B* in *Fig. 34*, but only one leaf is shown in order to simplify them. It is obvious, now, that when the internal ring was turned one way or the other a little the leaves would open or close.

The *brake* or *speed adjustment*, see *C*, which controls the time it takes for the leaves to open and close, *i.e.*, the time of exposure, is formed of a cylinder that is closed at both ends and in this is a piston that has a slot in the middle of it, and it is regulated by a curved lever. Now when the piston is made to move toward one end of the cylinder by the lever, it compresses the air in it and at the same time it sets up a partial vacuum in the other end.

The speed at which the piston moves depends on its original position at the time it is released, and it is the highest when it is exactly in the middle of the cylinder. The variation of the

speed of the piston, and, hence, of the leaves of the shutter, is controlled by setting the piston in a given position in the cylinder; this is done by turning a disk which has the seconds and fractional parts of the second marked on it, *i.e.*, say from 1 to 1/100 of a second.

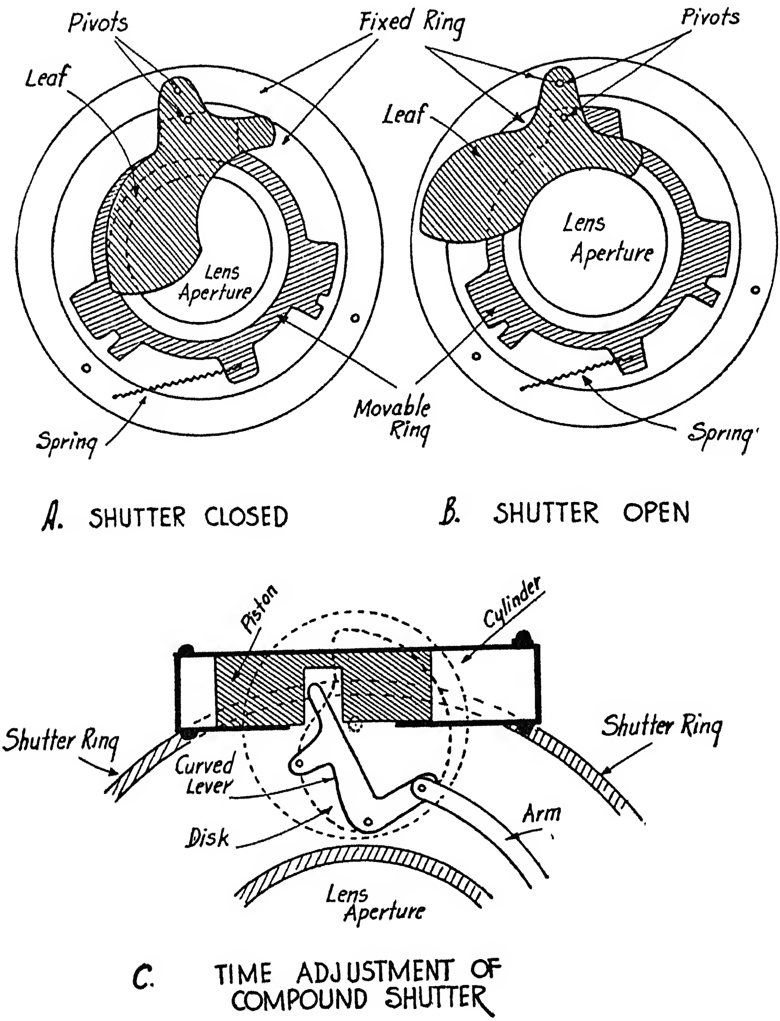


FIG. 34.—THE DECKEL COMPOUND SHUTTER

When the disk is turned it moves a cam and this in turn moves the curved lever, one end of which passes into the slot in the piston. The other end of the lever is pivoted to a drum which has the driving spring in it and this is secured to an internal ring with leaves on it.

The Iris and Iris Diaphragm Shutters.—These shutters were developments of (*1*) the iris diaphragm which I described in the preceding chapter, and (*2*) the foregoing multiple-leaf shutter. The *iris shutter* consisted of ten or a dozen arcuated leaves pivoted at equidistant points to an external and an internal ring and as they opened and closed they formed an approximately true circle of constantly expanding and contracting size just as the iris diaphragm does.

Now since the iris diaphragm and the iris shutter are made and work exactly the same, in so far as the movement of their leaves is concerned, it was obvious that one set of leaves could be used for both the diaphragm and the shutter and so the *iris diaphragm shutter* was devised. The two chief shutters of this kind were the *Volute* and the *X-Excello,* but these have not been manufactured for several years. This is quite too bad for the shape of their leaves gave a greater illumination with a smaller motion, and they were the thinnest between-the-lens shutters that have yet been made and, hence, were especially useful for wide-angle lenses.

The reason they were discontinued was because they were quite complicated, and got out of order easier than those where the iris diaphragm was separate from the shutter leaves and, finally, they cost considerably more. If the lens of your camera has an iris diaphragm shutter and it is in need of adjustment or repair you can send it to the *Bausch and Lomb Optical Company,* Rochester, New York, the makers of the *Volute,* and they will take care of it for you.

The Roller-blind Shutter.—This was a modified form of the drop shutter, and it was invented by Relandin, of France, in *1855,* and further improved upon by Kershaw, of England. Later on it was used in England in portable cameras, and it was placed immediately before or just behind the lens.

It consisted of a flexible, opaque blind or curtain that had a

horizontal rectangular slit or opening in it and this was wound on a pair of rollers, one of which had a spring in it very much like that of a window-shade. The blind was wound up and set by pulling on a cord which was wrapped on a grooved pulley secured to one end of the roller, and when an exposure was to be made it was released by means of a spring catch.

The Focal-plane Shutter.—Finally, the focal-plane shutter is a greatly improved form of the roller-blind shutter. It was devised by Farmer, of England, in *1882,* but it did not come into use until Anschütz, of Germany, used it for making high-speed exposures of animals in motion. It is called a *focal-plane shutter* because it is fixed in the camera at as near the focal plane of the lens as possible and yet does not actually touch the plate or film.

The early form of focal-plane shutter consisted of a two-part blind, whose adjacent free ends were secured to a pair of rods; the latter were connected by means of a cord in such a way that when an exposure was to be made the rods and, hence, the blinds, would open to the width of the plate and then close again. The operation of the shutter on this principle was too slow and so Huttig, of Germany, made one in *1900,* in which the blind had a narrow slit or opening in it, and when the blind was released, the slit passed over the surface of the plate or film at a high speed and so made the exposure.

One of the best of the early shutters that was based on this principle was made by Sigriste, of Italy, and it was formed of a pair of metal strips that moved across the plate or film at a distance of only 1/100 of an inch from the surface of it. The strips could be set so that the opening between them was from 1/100 of an inch on up to *2* inches, and by adjusting the width of the opening and the tension of the spring the time of exposure could be varied from 1/40 to 1/5000 of a second. This type of focal-plane shutter was later brought to a high degree of perfection by C. P. Goerz, of Germany, and is now merged with the Zeiss *Ikon.*

Present-day Shutters.—At the present time there are only three fundamental shutters in use, and these are (*1*) the rotary shutter, (*2*) the leaf shutter and (*3*) the focal-plane shutter.

All of these shutters have been so greatly improved upon that they are like their grand-daddies in basic principle only; they are marvels of inventive ingenuity and mechanical construction and, it follows, in operative efficiency.

The Rotary Shutter.—This is the simplest of the foregoing shutters and it is the kind that is used in box cameras like the Brownie, Kodak Bantam, and Eastman Bullet. The *Kodo* is an improved rotary shutter of the double-acting trigger kind, and it is used on folding cameras of the cheaper makes, while the *Kodal* or *Jiffy* shutter is a refinement of the Kodo shutter in that it has a single acting trigger. All of these shutters are extremely simple in construction and effective in operation.[1]

The rotary shutter is self-setting and it can be used for making either snap-shots, *i.e.*, exposures of $\frac{1}{30}$ of a second, or time exposures by means of an adjusting bar. In its simplest form it consists of five parts and these are (*a*) a supporting plate, (*b*) a blade or sector, (*c*) a release trigger, (*d*) a spring, and (*e*) a control rod.

To the supporting plate, which is shown at *A* in *Fig. 35*, is pivoted the sector blade and this has an oval hole cut in the margin of it. The release trigger is a brass angle lever that is pivoted to the supporting plate, and to one end of it is secured one end of a looped spring wire, while the other end of the latter is fixed to a pin in the sector blade, all of which is shown at *B* and *C*. The shutter, when it is assembled, is attached to the lens plate in the front end of the camera box, so that the hole in the plate is directly over the aperture of the lens, while the free end of the lever projects through the slot in the box.

Now the way the shutter works is like this: Normally it is closed, that is, the aperture of the lens is covered by the solid part of the sector blade, and all you have to do to make a *snap-shot exposure,* is to press the projecting free end of the trigger over either way, it doesn't matter which way, and *just once,* when the tension of the spring either pushes or pulls the sector far enough over very quickly so that the opening in it passes

[1] All of the above shutters are made by the *Eastman Kodak Company,* Rochester, New York.

clear across the one in the fixed supporting plate and, hence, the aperture of the lens.

The control rod, which is simply a strip of metal with the lower end bent over a little, slides in a grooved plate which is secured to the lens support of the camera. Now when the rod is pushed down, which is its normal position, the bent end just misses a projection on the sector and the opening in the latter

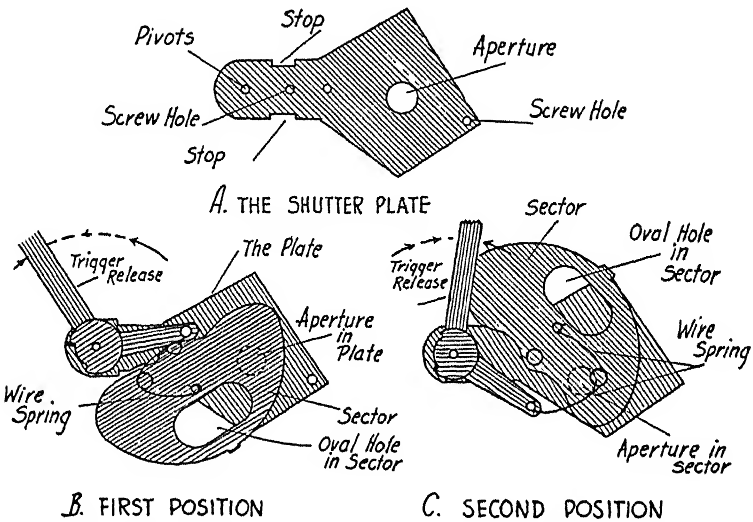


FIG. 35.—HOW THE ROTARY SHUTTER IS MADE AND HOW IT WORKS

moves clear across the aperture of the lens when a snap-shot exposure is made.

To make a *time exposure* the control rod is pulled up, and when it is in position and you push the trigger over the projection on the sector strikes the bent end of the rod and the latter stops it when the opening in it (the sector) is directly over the aperture of the lens. To close the shutter you must push the trigger again, but this time in the opposite direction, when the spring will throw the sector back to its original position.

The Packard Three-leaf Shutter.—The *Packard Ideal Shutter,* as it is called, has three leaves and this has the advantage over

the original two-leaf one, of a large opening in a much smaller size, and it is fitted inside of the front board of the camera instead of on the hood of the lens.

It is made in two styles, and these are (*1*) for time exposures only, and (*2*) for time and instantaneous exposures. It is changed from *time* to *instantaneous* by simply pushing in or pulling out a small pin which passes through the front board of the camera into the shutter. The shutter automatically sets itself after each exposure and, it follows, is always ready for operation.

Multiple-Leaf, Inter-lens, or Between-the-lens Shutters. —As its first name indicates a shutter of this kind is formed of a number of leaves, and its second and third names signify that it is secured to the barrel of the lens mount between the components of the objective. The design and construction of the shutters of various makers and the models they make differ in numerous mechanical details but, in the last analysis, they are all alike in that time, bulb, and instantaneous exposures can be made with them. Nearly all of the folding hand cameras are fitted with between-the-lens shutters except those of the *reflex type,* such as the *Graflex* and the miniature cameras like the *Contax* and *Leica.*

Practically all between-the-lens shutters at the present time are made with either three, four, or five leaves, depending on the size of the shutter, and as these open they form a radial or star-shaped opening as shown in *Fig. 36,* and this gives a far more even distribution of light over the whole plate or film in a lesser time than where two leaves only are used.

The cheaper kinds of folding cameras have lenses that are fitted with shutters which have three, four, five, and six different speeds, the latter ranging from $\frac{1}{2}$ to $\frac{1}{100}$ of a second. The better makes of cameras have lenses whose shutters have no less than eight speeds and these range from *2* seconds to $\frac{1}{250}$ of a second.

These shutters usually have two small rotatable disks pivoted to their outer plates, and under or over them are two fixed pointers or marks on these outer plates. The smaller disk has the letters *T, B* and *I* marked on it which, of course, means *time, bulb* and *instantaneous* exposures, while the larger disk

has the figures and fractions marked on it which show the different time intervals of exposure. If, now, you want to make a *time* exposure you turn the small dial until the pointer or mark is in a line with the letter *T*, and then turn the larger disk round until the pointer or mark is in a line with the figures

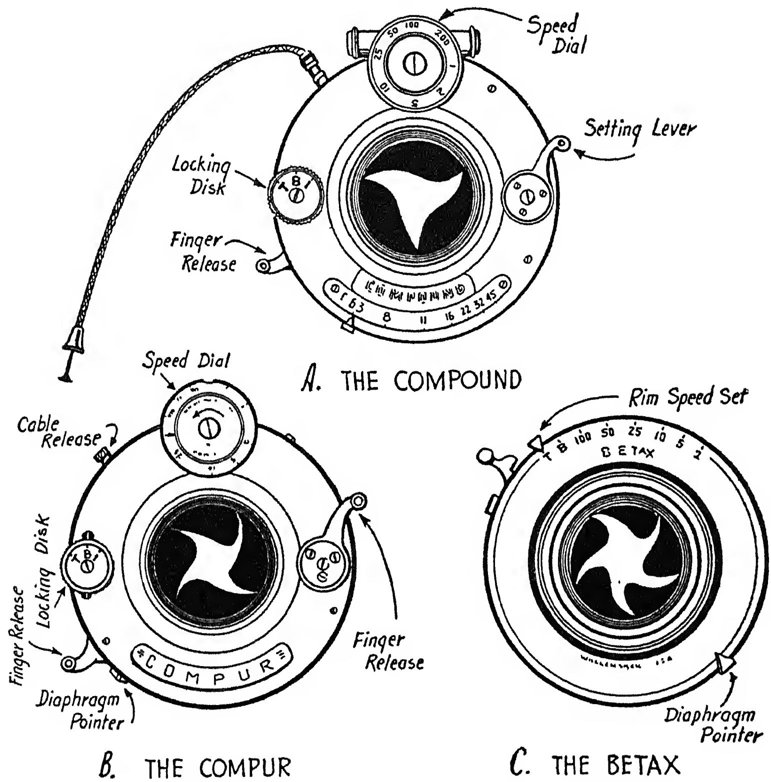


FIG. 36.—KINDS OF BETWEEN-THE-LENS SHUTTERS

which represent the time intervals in seconds or fractions thereof that you want the exposure to be.

Now shutters are made in three chief styles and these are (*1*) automatic, (*2*) setting, and (*3*) a combination of these two. If the shutter is *automatic* to make the exposure you need only to release it by whatever means with which it is fitted. If it is

a *setting* shutter you must set it by pulling over the setting lever, and if it is a combination of these two means then you must set it for making a time exposure, but you need not do so for a bulb exposure.

Kinds of Between-the-lens Shutters.—There are several makes of between-the-lens shutters, the better known ones of which are (*1*) the Compur, and the Compound, of *Bausch and Lomb;* (*2*) the Acme, Universal, and General, of the *Ilex Company;* (*3*) the Betax, Deltax, and Gammax, of the *Wollensak Optical Company;* and (*4*) the Kodamatic, and others, of the *Eastman Kodak Company.*[2]

The chief difference between the *Compur* and the *Compound* shutters is that the former is used with the smaller-sized lenses of folding cameras, and the latter with the larger-sized lenses of them. Both of them are of the combination setting and automatic type. They are high speed and very compact, have both bulb and time exposures and are automatic, *i.e.*, the shutter does not have to be set, while instantaneous exposures are made by setting a lever.

These shutters are of the three- and four-leaf type, see *A* and *B* in *Fig. 36,* and they are made in six models, to wit, the *Nos. 0* and *1* have maximum speeds of 1/250, the *No. 2* (which is the Compur) of 1/150, the *No. 3* of *100;* the *No. 4,* of 1/75 and the *No. 5,* of 1/50 of a second respectively. The *No. 0* has a lens opening of *1*$\frac{1}{16}$ of an inch, a diaphragm opening of $\frac{7}{8}$ inch, and costs *$16.50,* while the *No. 5* has a lens opening of *3*$\frac{1}{4}$ inches, a diaphragm opening of *2*$\frac{9}{16}$ and costs *$45.00.*

The *Acme,* the *Universal* and the *General* are high-grade controlled five-leaf shutters and are made in the above three-named models. The *Acme* is a time and bulb setting shutter and it is made in six sizes; the first of which has speeds that range from *1* to 1/300 of a second, and costs *$14.50* to *$20.00* according to the diameter of the lens opening, which ranges from $\frac{7}{8}$ of an inch to *2*$\frac{5}{16}$ inches.

The *Universal* is a time and bulb, automatic shutter and it is likewise made in six sizes. It has a range of speeds from *1* to 1/100 of a second, and costs from *$11.50* to *$16.00.* Lastly, the *General*

[2] All of these companies are located at Rochester, New York.

is a time and bulb, automatic shutter that is also made in six sizes. It has speeds ranging from $\frac{1}{5}$ to $\frac{1}{100}$ of a second and it costs from *$9.00* to *$16.00*.

The *Betax, Deltax* and *Gammax* shutters all have time and bulb exposures and the speeds are controlled by a retarding gear that is quite like the escapement of a watch and, hence, they are rim-set. The *Betax,* which is shown at *C* in *Fig. 36,* is made in six sizes with openings of $\frac{9}{16}$ of an inch to $2\frac{1}{4}$ inches, have five speeds ranging $\frac{1}{2}$ to $\frac{1}{100}$ of a second, and cost from *$9.00* to *$20.00* each.

The *Gammax* shutter is made in three sizes with openings of from $\frac{9}{16}$ to *1* inch, has four speeds of from $\frac{1}{10}$ to $\frac{1}{100}$ of a second, and costs from *$4.50* to *$6.50*. Lastly the *Deltax* is made in two sizes, with openings of $\frac{9}{16}$ and $\frac{3}{4}$ of an inch, have three speeds ranging from $\frac{1}{25}$ to $\frac{1}{100}$ of a second, and costs *$4.00* and *$5.00* respectively.

There is quite a family of the Kodak between-the-lens shutters, namely (*a*) the Kodex, (*b*) the Kodon, (*c*) the Diodak and Dakar, and (*d*) the Kodamatic. The *Kodex* is a simple type of automatic shutter with an iris diaphragm and the conventional *T, B,* $\frac{1}{25}$ and $\frac{1}{50}$ instantaneous exposures. The *Kodon* shutter is a refinement of the Kodex type; it has the additional speed of $\frac{1}{100}$ of a second, and has the diaphragm and shutter speed scales visible on the top of the shutter as well as on the front.

The *Diodak* and *Dakar* shutters are elaborations of the Kodon with an additional speed of $\frac{1}{10}$ of a second. The *Kodamatic* shutter is an advanced type of the above shutters. It has a wide variety of speeds with a gear-train retard and is necessarily of the setting kind, hence it is not affected by temperature and atmospheric conditions.

Kinds of Time Control Devices.—Various mechanical devices are used on different makes of between-the-lens shutters for controlling the time of exposures and chief among these are (*a*) the spring, (*b*) the lever, (*c*) the gear and (*d*) the air compressor. The *spring* and the *lever* controls give very accurate exposure values of from $\frac{1}{25}$ to $\frac{1}{100}$ of a second, while the *gear* and the *air compressor* controls provide greater accuracy and higher speeds where the exposures range from *1* second to $\frac{1}{100}$ of a

second. Where a spring, lever, or a gear control is used it is placed inside the case and, hence, they are *rim-set,* that is, set by a lever on the rim, but where an air compressor is employed (see *Fig. 34,* again), it is generally mounted outside on top of the case.

About Servicing Between-the-lens Shutters.—A shutter of this kind is about as complicated as a watch, and is constructed and assembled with virtually the accuracy of the latter. Again like a watch it does not easily get out of order and, it follows, it seldom needs servicing, unless, of course, it has been carelessly handled or grossly misused.

Now just as you would not think of trying to repair your watch should it fail to function, but you would instead take it to a watchmaker so, also, should your shutter become inoperative, I would suggest that you do not attempt to fix it yourself but take it to an expert whose business it is to repair them.

Should you want to gather at first-hand exactly how a shutter is made and works the thing to do is to get a discarded one and take it apart, and as you do so lay each piece out in sequence on a sheet of paper. After you have done so, if you can put them all back together again so that all of the parts are in place and the shutter is in working order you will be able to service one of any make.

Note.—Never clean the exterior of your shutter with any kind of a liquid, and do not put oil on the leaves or any other part of it, or you will throw the speed of it entirely out of its normal setting.

Kinds of Shutter Releases.—There are four chief kinds of shutter releases and these are (*1*) the trigger release, (*2*) the bulb release, (*3*) the cable release, and (*4*) the automatic or self-timing release.

The *trigger release,* or *finger release* as it is also called, consists of a little pivoted lever, with a hole in the free end of it, that projects from the case of the shutter, and which is connected with the trip mechanism. To release the shutter you simply press down on it, or you can tie a string to the free end of it and pull it down.

The *bulb release,* as I have previously mentioned, includes a thin cylinder in which there is a sliding piston and this is con-

nected with the trip of the shutter. One end of a rubber tube is connected with the small end of the piston and the other end is attached to a rubber bulb. Now when you want to release the shutter you simply press the bulb which compresses the air in it and this makes the piston slide through the cylinder to the other end and so release the trip.

The bulb release has been practically superseded by the *cable release* and this is formed of a flexible wire that passes through a flexible tube. One end of the wire is connected with the trip of the shutter and the other and free end terminates in a button. To release the shutter you hold the end of the tube between your fingers and press down on the button with your thumb.

The *automatic* or *self-timing release* is, as its name indicates, one that automatically releases the shutter so that you, as the operator of the camera, can have time to take your position before the lens and be included in the picture in the case of a group, or you can take self-portraits with it. Now there are two chief kinds of self-timers and these are (*1*) the Kodak and (*2*) the Fernar, and either of these will actuate any shutter that is fitted with a cable release.

The *Kodak* self-timer consists of a cylinder that is fitted with a piston which is motivated by a spring; you set it for the time interval you want to elapse before it releases the shutter, and this can be anywhere between ½ a second and *1* minute. This done you take your place in front of the lens and remain there until you hear it *click* which tells you that the exposure has been made. This useful little gadget costs the small sum of *$1.25*.

The *Fernar* self-timer is built in two different models, the *No. 1* actuating the shutter when it is set at some particular speed. This one costs *$1.50*. The *No. 2* actuates the shutter when it is set *at bulb* and it will then open it at intervals of from *1* to *10* seconds, at which time it will automatically close it. The price of it is *$2.50*.

The Graflex Focal-plane Shutter.—As its name indicates this shutter is used with the *Graflex* and the *Graphic* cameras. It consists of a long curtain with five different-sized openings in it which vary from ½ of an inch wide to the full size of the plate or

film, as shown at *A* in *Fig. 37*. Since the openings are fixed an absolutely uniform rectangular opening is insured at all times.

The curtain operates as closely as possible to the surface of the plate or film without actually touching it and the length of time of exposure is regulated by (*a*) the size of the opening in

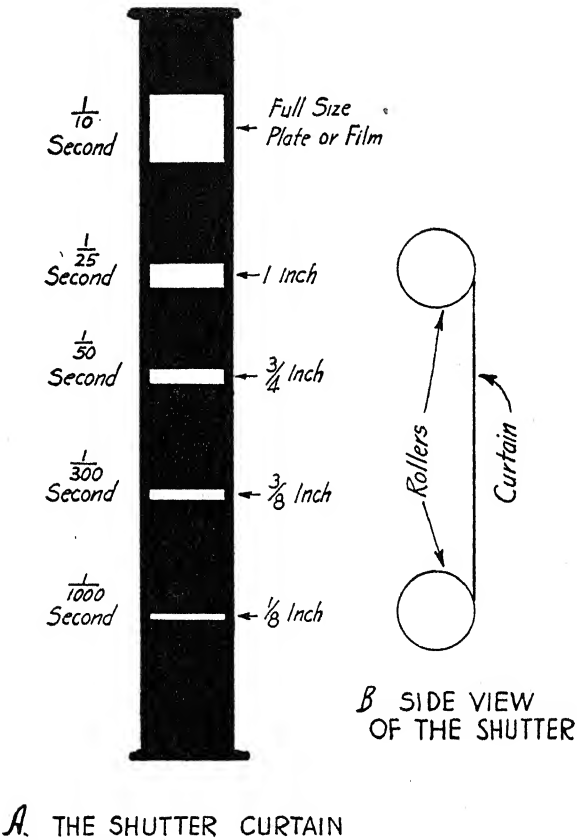


FIG. 37.—THE GRAFLEX FOCAL-PLANE SHUTTER

the curtain that is used and (*b*) the speed with which it moves across the focal plane. The advantage of the focal-plane shutter over those of between-the-lens kind which I have previously described will be discussed a little further along. The focal-plane shutter is pictured at *B*.

The shutters of the Graflex cameras with the exception of the *Home Portrait* and *National* models, are adjusted to give instantaneous exposures of from $\frac{1}{10}$ to $\frac{1}{1000}$ of a second. The Home Portrait and National models have maximum speeds of $\frac{1}{500}$ of a second. The following table shows the exposures that can be made with the various curtain openings and different spring tensions:

TABLE OF GRAFLEX FOCAL-PLANE SHUTTER SPEEDS

TENSION NUMBER	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$
1	350	110	40	10
2	440	135	50	15
3	550	160	65	20
4	680	195	75	25
5	825	235	80	30
6	1000	295	90	35

The first vertical line of figures on the speed table indicates the tension on the curtain spring, the curtain moving with the greatest speed when the spring is wound to the highest tension which is *No. 6,* while the first horizontal line of figures, *i.e.*, $\frac{1}{8}$ inch, etc., shows the width of the curtain opening.

The narrower the opening that moves across the focal plane and the higher the tension number that is used the shorter the exposure will be. The numbers *10* to *1,000* indicate fractions of a second in shutter speeds, *1,000* showing when the tension spring is wound to *6* and the curtain opening is set to $\frac{1}{8}$ of an inch when, it follows, the exposure will be $\frac{1}{1000}$ of a second and so on for all exposures of from $\frac{1}{10}$ on up to $\frac{1}{1000}$ of a second. By setting the curtain at *o*, that is, *open,* and letting the rising mirror of the camera end the exposure an automatic exposure of about $\frac{1}{5}$ of a second can be made, and, finally, the shutter can be set so that time exposures of any length can be made.

The Miniature Camera Focal-plane Shutter.—The focal-plane shutter of the Leica, Contax, and other miniature cameras, are quite alike in all essential respects. The parts of it are made

of light metal and, hence, it has a high resistance to changes in both temperature and climatic conditions as well as to mechanical wear. It is automatically coupled with the film-winding mechanism so that when you wind up the shutter the film is also transported, that is, moved into position for making the next shot, and this prevents accidental double exposures.

The shutter, which is shown at *A* and *B* in *Fig. 38*, consists of

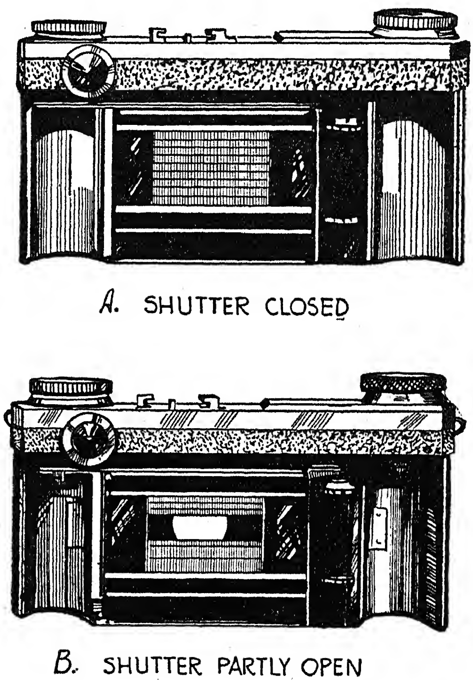


FIG. 38.—THE FOCAL-PLANE SHUTTER FOR MINIATURE CAMERAS

a pair of metal blinds which operate with great accuracy. The Contax shutter is made in two models namely (*a*) Contax I, and (*b*) Contax II and III. Contax I gives the following speeds: $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$, $1/25$, $1/50$, $1/100$, $1/200$, $1/500$ and $1/1000$ of a second, and also *bulb* and *time* exposures. The Contax II and III give these speeds: $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$, $1/25$, $1/50$, $1/125$, $1/250$, $1/500$ and $1/1250$ of a second, and also *bulb* and *time* exposures.

You can make exposures of $1/25$ or $1/50$ of a second with your camera held in your hand and get pictures that are marvelously sharp, and if you are experienced in using the camera you can make them as slow as $\frac{1}{10}$ or $\frac{1}{5}$ of a second and still get them sharp.

The Efficiency of the Focal-plane Shutter.—The word *efficiency* when used in connection with a photographic shutter means the actual amount of light that reaches the plate or film during a given time of exposure. Now the difference in the efficiency of a between-the-lens shutter and a focal-plane shutter is due to the fact that in the former the leaves take (*a*) an appreciable length of time to open and close and (*b*) the shape of the

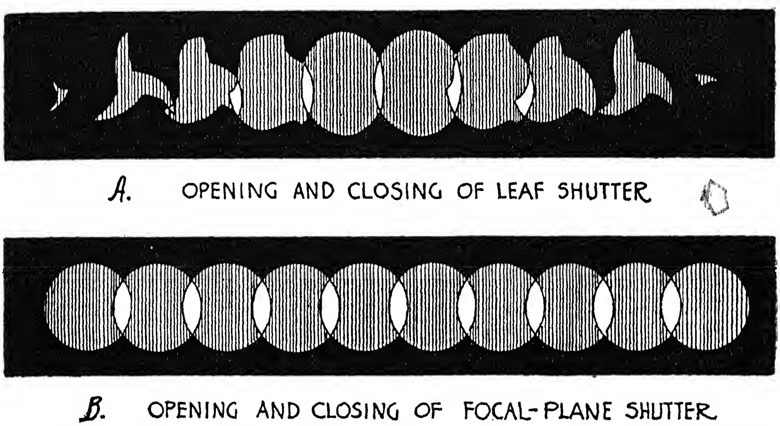


FIG. 39.—RELATIVE EFFICIENCY OF SHUTTERS

opening they make allows a greater amount of light to pass through the center of the lens than the margin of it.

The strip pictured at *A* in *Fig. 39* shows that when an exposure is being made with a between-the-lens shutter it is *wide open* only during the fifth and sixth flashes. The efficiency of the best shutter of this kind is in the neighborhood of from *50* to *60* per cent.

With a focal-plane shutter there is no loss of time from the instant the exposure begins until it ends since the opening is always the same throughout the duration of it. The strip at *B* shows that the amount of light does not decrease with the opening and

closing of the shutter and, hence, that the plate or film is uniformly illuminated throughout the exposure.

The efficiency of the best focal-plane shutter is from *80* to *90* per cent and, it follows, it gives far better results than a between-the-lens shutter, especially at the higher speeds. The pictures in *Fig. 39* were reproduced from actual photographs of the light that passed through a between-the-lens shutter and a focal-plane shutter. Both pictures were made under identical conditions with a lens at *f.4.5* aperture.

CHAPTER VI

HOW THE CHEMICAL IMAGE IS FORMED

When the optical image is formed on a ground-glass screen or other unsensitized surface by the rays of light it vanishes the instant they are cut off from it. The problem, then, that the early experimenters in photography had to solve was how to retain the image after the light rays which formed it had been removed.

As I have previously explained it was found that if a sheet of paper was coated with a solution of silver chloride ($AgCl_2$) and water (H_2O) when the rays of light fell on it it became black and where the rays were cut off from it it remained white. Thus it was possible to lay a flat object such as a leaf, a piece of lace, or a drawing made on translucent paper or on glass, on a sheet of the sensitized paper and make a picture of it that would last for a little time provided it was kept in a subdued light or, better, in a dark room.

What the Latent Image Is.—Now while pictures could be made on paper coated with silver chloride it was not nearly sensitive enough to react to the rays of light when it was placed in a camera and an image of some exterior object was formed on it by a lens. It was finally discovered, however, that it was not necessary for the light rays which passed through a lens to form an image which could be seen on the paper after it was removed from the camera, but that the sensitized paper needed only to be acted upon by the light rays for a short time for a *latent image* to be impressed on it, that is, one which was actually there but which was not visible to the eye. Further, it was found that it was possible to *bring out* the latent image by treating it with certain chemicals, or *develop it* as it is called.

How the Sensitive Emulsion Is Made.—An emulsion[1] is

[1] We get the word *emulsion* from the Latin root *emulgere* which means a *jellylike substance.*

any liquid or jellylike substance in which minute solid particles remain suspended, just as fat globules do in milk. In photographic chemistry an emulsion is a silver salt that is held in suspension in albumen, collodion, or gelatin that is used for coating plates, films, and papers to make them sensitive to light rays.

The emulsions for plates and films that are used at the present time are made of gelatin which has been sensitized with silver bromide ($AgBr$). Now gelatin is a glutinous substance that is extracted from the tissues of animals by prolonged boiling, and its chief characteristic is that when it is dissolved in hot water it becomes a liquid and when it cools it forms a jelly.

To make an emulsion that is sensitive to light rays the gelatin is soaked in cold water until it has absorbed as much of the latter as it can when it will swell up to about twice its original size. It is then gently heated and stirred when it becomes a liquid that is about as thick as molasses. While it is in this viscous condition a given amount of ammonium bromide (NH_4Br) is stirred into it when it dissolves.

The next step is to dissolve the proper amount of silver nitrate ($AgNo_3$) in water (H_2O), and this is gradually added to the liquid gelatin that has the ammonium bromide in it. Now the silver nitrate solution of and by itself is not sensitive to light rays but it instantly becomes so when it is mixed with the gelatin as the latter is an organic compound. For this reason the foregoing operation and all of those that follow it in the making of *photographic materials,* as the sensitized plates and films are called, and the development and fixing of them, must be done in the dark, *i.e.,* in a darkroom or in a light-tight tank.

As the silver nitrate is slowly added to the liquid gelatin the particles of the former do not settle to the bottom of it as it would if it were added to water, as shown at *A* in *Fig. 40,* but are evenly distributed through it and they will remain suspended in it when it has become a jelly, see *B,* or completely solidified when a plate or film is coated with it.

To go back a little now, let's find out what takes place when the silver nitrate solution is added to the ammonium bromide that has been mixed with the liquid gelatin. When the atoms of the silver nitrate ($AgNO_2$) and those of the ammonium bromide

(NA_4Br) come in contact with each other a chemical reaction takes place between them, the atoms of silver (Ag) of the silver nitrate, and those of the bromine (Br) of the ammonium bromide, combine and form silver bromide ($AgBr$), while those of the nitrate (NO_2) of the silver nitrate, combine with the ammonia

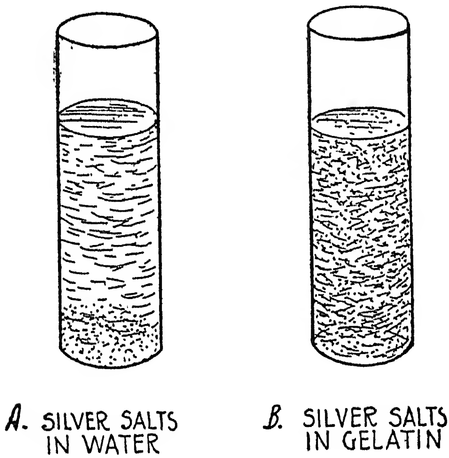


FIG. 40.—WATER PRECIPITATES SILVER SALTS; GELATIN HOLDS THEM IN SUSPENSION

(NA_4) of the ammonium bromide, and form ammonium nitrate (NH_4NO_3). The following chemical equation shows these reactions to better advantage:

$$\frac{AgNO_2}{\text{silver}} + \frac{NH_4Br_3}{\text{ammonium}} = \frac{AgBr}{\text{silver}} + \frac{NH_4NO_3}{\text{ammonium}}$$

$$\text{nitrate} + \text{bromide} = \text{bromide} + \text{nitrate}$$

To make the emulsion still more sensitive to light rays it is heated and cooled several times and this process is called *ripening*. When it has again set to a jelly it is shredded in a machine and then soaked in water until the ammonium nitrate is dissolved out of it and the silver bromide is left in it. The emulsion is again heated and some alum is added to it to make the gelatin a little harder and more resistant to swelling, and the plates or films are then coated with it.

In the early days dry plates were coated by hand as shown in the frontispiece but films are now coated by machines. They are then dried and sealed up in light-tight boxes or rolls ready for the market. All of the above operations are, of course, carried on in darkrooms with the aid of a feeble red light, and even this must be dispensed with where panchromatic emulsions are being made and plates and films are coated with it, as these are also sensitive to the red rays of light. The darkrooms must also be dust-proof and this is accomplished by means of air filters.

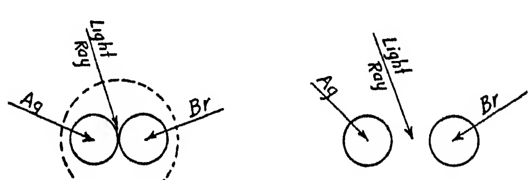
How Light Acts on Silver Compounds.—As you have seen above silver nitrate is sensitive to light rays only when it is in contact with some kind of organic matter, that is, it is decomposed when it is subjected to the energy of light rays, but it is very slow when compared to silver bromide. For this reason it is not used directly as a sensitizing agent for photographic materials, but it is, as you have seen, employed as a starting point for making silver bromide.

Now just as a ball when it is thrown has energy stored up in it, so do light rays contain stored up energy and when these come in contact with various chemical substances, but especially those that are formed of silver, the energy of them breaks the latter down, or *dissociates* them as it is called, and separates them into their original elements.

The action of the energy of the light rays on silver bromide is quite simple, as the following equation clearly shows:

$$\underset{\text{silver bromide}}{\text{AgBr}} + \underset{\text{energy}}{\text{light}} = \underset{\text{silver}}{\text{Ag}} + \underset{\text{Bromine}}{\text{Br}}$$

Or it can be pictured schematically thus:



MOLECULE OF SILVER BROMIDE

ATOM OF SILVER

ATOM OF BROMIDE

How the Latent Image Is Brought Out.—When the above action has taken place, *i.e.,* the rays of light have broken down the molecules of silver bromide and so separated the silver atoms of them from the bromine atoms, the chemical image or *latent image* as it is called, is formed on the plate or film, but there is no visible change in the sensitive coating of them.

To bring out the latent image so that it can be seen and a print can be made from it the plate or film must be immersed in a developing agent, or *developer* as it is commonly called. Now what the developer does to bring about this result is to combine with the bromine that has been set free from the silver bromide and to leave the free silver and the silver bromide that the light rays have not acted on in the gelatin.

Silver in its pure state is, as you know, a bright, white metal, but when it combines with sulphur (S), silver sulphide (AgS) is formed and this is a black compound. Now there is a trace of sulphur in gelatin, and it is also present in developers in the form of sodium sulphite (Na_2SO_4), and it is this, presumably, that combines with the surface of the free atoms of silver in the emulsion and turns them black, just as silverware becomes black when sulphur fumes act upon them.

After the latent image has been made visible by developing the plate the silver bromide in the emulsion that has not been acted on by the rays must be dissolved out before it can be taken out of the darkroom and further exposed to the light. This is done by immersing the plate or film with the visible image on it in a *fixing solution.* The way that developers and fixers are made, used and act on plates and films will be described in due course of time.

CHAPTER VII

THE CAMERA AND ALL ABOUT IT

I. THE BEGINNINGS OF THE CAMERA

THE ancient Latins called a *vault* or an *arch* a *camera,* and the later Latins called a *chamber* or a *room,* a *camera.* In English-speaking countries a *camera* has come to mean but one thing, and that is a boxlike contrivance which is used to take photographs with. The beginning of the camera dates back to prehistoric times, and this is the way it is supposed to have come about:

Ethnologists are now at variance as to where civilization was cradled but as good a guess as any is that it took place on the Iranian plateau, which is now called Persia. It was here that the human race first began to till the soil, domesticate wild animals and to herd them, to weave the wool of the argili,[1] make pottery and to live in tents and rude huts. They also observed the stars and various other natural phenomena, but they hadn't the faintest idea of what it was all about.

In the heat of the day they would seek the solace of the darkened tent or hut, and wherever there was a little hole in it and an animal or an object on the outside was in a direct line with it, the light that was reflected back from it through the hole caused an image of it to be projected on the opposite wall or on the floor. This then, it is easy to believe, was the very beginning of the camera.

Now thousands of years after these alleged observations of the Irans, the Greek philosopher and mathematician Euclid,[2] of Alexandria, as we have said before, used a board with a hole in it to prove to his students that light travels in straight lines, and this then, was the second definite step that was taken toward the invention of the camera. Who it was that actually made the first

[1] The *argili* was the ancestor of the domesticated sheep.

[2] He was born about *440* B.C., but the date of his death is not known.

box with a minute hole in it so that it would project the image of an illuminated object which was in a line with it is not, more's the pity, known.

The first written description of the invention of the box camera was made by Roger Bacon,[3] an English philosopher, in the *thirteenth* century, when he told in hazy language about an apparatus that had a mirror on it for viewing pictures, and then in the *fifteenth* century Leon Battista Alberti [4] described a similar apparatus in a like vague way. It remained for the great Leonardo da Vinci,[5] in the *sixteenth* century to clearly explain how to make a *pinhole camera* and to show a sketch of it as well, and this manuscript of his is now in the Bibliothèque Nationale in Paris.

To Daniello Barbaro,[6] of Italy, is due the credit of having been the first to use a lens in a camera, and this he did in *1568*. As the lens made a much sharper and brighter image than the pinhole it was used as an aid to drawing pictures and also to get the correct shading and natural coloring of the object. Barbaro was also the first to point out the advantage of *stopping down the lens,* and the way he did this was by covering the margin of it with a ring of opaque paper, which left the center of it open.

Later on Barbaro's camera was improved upon by the great astronomer and mathematician Johannes Kepler,[7] of Germany, who devised a better lens for it. He called it a *camera obscura,*[8] and it consisted of a light-tight box that had a lens in one end and a mirror set at an angle of *45* degrees at the other end and, finally, a sheet of clear glass placed parallel with the mirror above it. To make a drawing of the object whose image was projected on the mirror and then on the glass, a sheet of translucent paper was fixed to the latter. The camera obscura was largely used by artists and others for making drawings clear up to the time that the art of photography was discovered.

[3] He lived from *1214-94*.

[4] He was an Italian architect and lived from *1404-72*.

[5] He was an Italian architect, painter, sculptor and engineer—in a word a universal genius. He lived from *1462* to *1519*.

[6] He lived from *1518-80*.

[7] He lived from *1571-1603*.

[8] The word *obscura* comes from the Latin *obscurus* which means *dark,* and it follows, a *camera obscura* means a *dark box.*

A larger form of the camera obscura consisted of a small room or an opaque tent, with a mirror and a lens on top of it, the light from the object being reflected by the former down and through the latter; the image was projected on the white surface of the top of the table. It was employed as a scientific diversion for many years.

Finally, the first camera that was used for actual photographic work was made by Sir Humphrey Davy,[9] the great English chemist, in *1802*. He fitted it with a ground-glass screen and a holder for the sensitized plate, and he and Thomas Wedgwood used it for their experiments in taking photographs. From that time on until the latter part of the *nineteenth* century, the camera was improved upon in its constructional details for the especial benefit of the professional photographer, but the aggressive pioneering amateur likewise gained in the advantage it offered.

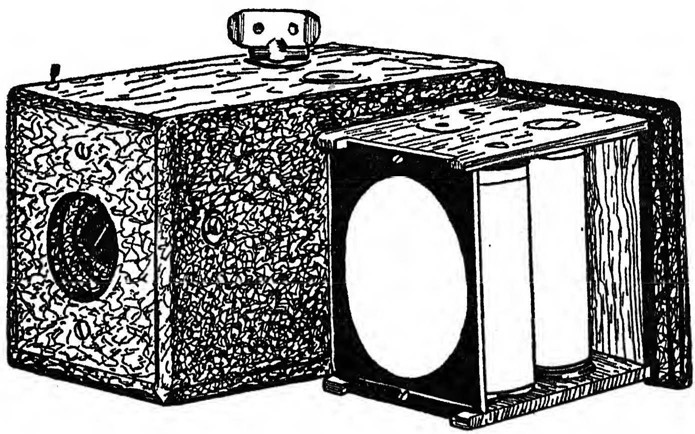


FIG. 41.—THE FIRST KODAK (1888)

Amateur photography, however, as we of to-day understand the term, *i.e.,* where every one can take pictures, did not come into being until *1888,* when George Eastman put the first little hand camera on the market under the trade-name of *Kodak*. It was fitted with a supply spool and a take-up spool (*Fig. 41*), and it used a film that had to be stripped from a paper support.

[9] He lived from *1778* to *1829*.

The first *Pocket Kodak* was designed in *1895*, and this was followed in *1898* by the first *Folding Pocket Kodak,* and then in *1900,* the first *Brownie Camera* was put on the market, and this was primarily intended for children. All of these cameras were so successful that other companies began to manufacture cameras of a like nature, and fast and furious improvements have been made ever since, until in this year of grace *1938,* it seems that they are about as nearly perfect as it is humanly possible to make them.

II. KINDS OF PRESENT-DAY CAMERAS

In the early days of photography there were only two general kinds of cameras and these were (*1*) the indoor or studio camera, and (*2*) the outdoor or view camera, but with the progressive advances that have been made in the technic of the art, especially within the last few years, there is now a camera for every specialized purpose.

Since this is the way of it the kind of a camera you want will depend on several factors, the chief ones of which are (*a*) the kind of pictures you want to take, (*b*) the size of the pictures you want to take, and (*c*) the amount you want to pay for it. From this you will gather that the first thing to do is to learn about the different makes and various models that are now on the market, and the following text will give you a very good idea of them.

The Kind of a Camera You Want.—*Kinds of Pictures to Take.*—While you can take almost any kind of a picture with almost any kind of a camera, to get the best results you must have one that is especially designed and constructed for the specific work it has to do. Thus, cameras are made to take (*1*) snap-shots, or instantaneous pictures as they are called, of any and everything that you want to keep a photographic record of, (*2*) scenic pictures, (*3*) architectural subjects and interiors, (*4*) portraits and life subjects, (*5*) technical and scientific pictures, (*6*) three-color pictures, and (*7*) moving pictures.

Snap-shots or *instantaneous pictures* are taken with *hand cameras,* that is, cameras which are held in the hands while the exposure is being made, and these range in price from *$1.00* on up

to the sky as the limit. There is a great variety of these cameras to choose from, and they are made in all sizes and styles; they are fitted with lenses that range from the single achromat to the compound anastigmat, and with shutters from the simple disk type, thence through a whole series of between-the-lens type and up to the focal-plane type.

For taking *scenic pictures, architectural subjects,* and *interiors, portraits* and *life studies*[10] a *view camera* is the best kind for the semi-amateur to use, and there are special lenses that are used with it according to the kind of pictures you want to take. Finally, for taking *technical* and *scientific pictures, three-color pictures* and *moving pictures* special cameras can be had.

The Sizes of Cameras.—When we say that a camera is a *3¼ x 4¼*-inch one, or whatever the size of it may be, we do not mean that these are the overall dimensions of it but, instead, the size of the pictures it takes. The smallest size is the *miniature camera,* and with it you can make a picture that is either half the size or the full size of a moving-picture frame,[11] and from this the sizes run on up to the largest one that is used by the amateur and this is the *8 x 10 view camera.*

Now all cameras of whatever make or style are designed to take plates or films of standard sizes, and the table on the next page gives the width and length of them, while the pictures that are printed from them are a shade smaller. Obviously the smaller the pictures are that the camera takes, until you must have them enlarged in order to see the details in them, the smaller will be the cost of making them.

The Relative Merits of Cameras.—In buying a camera the actual size of it, as well as the size of the picture it takes, are factors of considerable importance. The box cameras and those that take pictures up to 3¼ x 4¼ inches, while very small, are of such a shape that they are not easily carried, even when in a carrying case. Some of the later models are 3 inches or a little less in width, hence they are not so bulky, and, it follows, they are more comfortable to carry.

[10] For professional work a regular studio camera is used, but for the amateur who works in homes for a consideration the view camera is the kind to use.

[11] A single picture on a moving picture film is called a frame.

Table of Standard Camera Sizes

½ x ¾	Candid or Miniature Cameras
¾ x 1	Candid or Miniature Cameras
1 x 1½	Candid or Miniature Cameras
1⅝ x 2⅛	Candid or Miniature Cameras
2¼ x 3¼	Candid or Miniature Cameras; Fixed-Focus and Folding Cameras
2½ x 2½	Candid or Miniature Cameras; Fixed-Focus and Folding Cameras
2½ x 4¼	Fixed-Focus and Folding Cameras
2⅞ x 4⅞	Fixed-Focus and Folding Cameras
3¼ x 4¼	Fixed-Focus and Folding Cameras
3¼ x 5¼	Fixed-Focus and Folding Cameras
4 x 5	Press Cameras
4½ x 5	Press Cameras
4½ x 6¼	Press Cameras; Portrait, View, and Architectural Cameras
5 x 7	Press Cameras; Portrait, View, and Architectural Cameras
6½ x 8½	Portrait, View, and Architectural Cameras
8 x 10	Portrait, View, and Architectural Cameras

The *raison d'être* for the invention of the folding camera is its portability. Even the largest size folds up so compactly that it can often be carried in your coat-pocket, and this is a great convenience. Moreover the folding camera since it costs from four to twenty times as much as a box camera is fitted with a far better lens, shutter, and finder and, hence, is superior to the latter in every way, that is, if you know how to use it.

Now there are two chief kinds of folding cameras and these are (*1*) the fixed-focus folding camera and (*2*) the adjustable-focus folding camera. Usually the *fixed-focus folding camera* will make a sharp picture of an object that is not closer than *8* feet from the lens and, hence, if you stand at this or a greater distance from the object everything in the picture will practically be in focus.

Oppositely disposed, when you want to take a picture with an adjustable focus camera you must focus it accurately which you do by moving the front of the camera that carries the lens forth or back over a scale that is marked with the number of feet the lens must be from the object, and this you do by sliding it along or by turning a wheel.

Now the bat in the ointment is that it is hard for the average person to judge the distance in feet that his camera is from the object he is going to take the picture of, and if he misses it by

a foot or two in focusing it the object will not be sharp. Many beginners buy expensive cameras but fail to get sharp pictures with them because they haven't the slightest idea of gaging distance; it follows, then, they can't focus their cameras accurately and the pictures they take are for this reason seldom satisfactory.

There is a little gadget, however, called a *range finder* and with it you can get the exact distance in feet that the object is from your camera, when you can focus the latter with precision. Ordinarily you have to hold it up to your eye and adjust it, and this of course you must do before you focus your camera. In some of the later and more expensive cameras, however, the range finder is a built-in part of the focusing device so that you can observe the distance as you focus the camera; I'll explain it in detail in another chapter.

Another advantage that the fixed-focus camera has over an adjustable focusing one is that it is always ready for instant action. All you need to do is to sight the object you want to take in the finder and release the shutter. The great advantage that the adjustable-focus camera has over the fixed-focus one is that when you do get the correct focus the picture will be sharper, the depth of field will be greater and it will have a brilliancy that you cannot get with an ordinary fixed-focus camera.

The *miniature camera, candid camera,* or *V.P.* (vest pocket) *camera* as it is variously called, is a highly developed instrument that takes pictures which range in size from $\frac{1}{2}$ *x* $\frac{3}{4}$ to $2\frac{1}{2}$ *x* $2\frac{1}{2}$ inches. The chief advantages of it are (*a*) its compact form, (*b*) in the smaller sizes it uses moving-picture film and, it follows, a large number of exposures can be made with a single loading, (*c*) since the size of the picture is so small and the anastigmat lens with which it is fitted has such a large aperture exceedingly quick exposures can be made with it and, lastly, (*d*) with the fine-grain film that is used with it the pictures can be highly enlarged without appreciable loss of detail. The miniature camera is in great vogue at the present time and you will find a full chapter that tells all about it further along.

When you are taking pictures of architectural subjects, machinery, interiors, and home portraits for money you must have a *view camera,* and this is fitted with a ground-glass screen, a

rising and falling front, a swing back and a reversible or a revolving back. The purpose of these several devices will be explained in Chapter XI.

The *press camera* is one with which you can take snap-shots under any and all conditions, and, it follows, it is the kind that is generally used by press photographers, *i.e.*, those who are engaged in taking pictures for newspapers, magazines, and other publications. There are three chief kinds of press cameras and these are (*1*) the Speed Graphic, (*2*) the Graflex, and (*3*) the high-grade miniature cameras.

The first two of the above named cameras take $3\frac{1}{4} \times 4\frac{1}{4}$, 4×5 and 5×7-inch pictures on either plates or cut films, while the miniature cameras use roll films. These cameras are fitted with the highest speed anastigmat lenses and focal-plane shutters and with them you can make exposures up to the $\frac{1}{1000}$ of a second. Scientific, three-color and moving-picture cameras will be discussed presently under their respective headings.

Various Types of Cameras.—Since there are numerous makes and models of cameras on the market it would, obviously, be impossible for me to give even a brief description of all of them. What I shall do, however, is to tell you about the chief American ones and some of the more important European ones that are sold over here.

Having explained before the broadly general differences in the various makes of cameras, if you will read the more or less detailed description of those which follow you will have no trouble in deciding on the camera that will satisfy your requirements and at the same time conform to the status of your pocket-book.

Cameras can be conveniently divided into two generic classes and these are (*1*) fixed-focus cameras, and (*2*) adjustable-focus cameras. *Fixed-focus cameras* can, again, be divided into two specific kinds, namely (*a*) box cameras, and (*b*) folding cameras. Fixed-focus cameras of either kind, from the cheapest to the most expensive, are often fitted with an adjustable lens mount so that they can be sharply focused on objects that are at two definite distances from the camera; this permits *close-ups* such as portraits to be made without the use of a special lens or a supplementary lens, as well as at a greater distance for groups, scenic pictures,

and the like. *Adjustable-focus* cameras are focused by means of either (*a*) a sliding movement, or (*b*) a rack and pinion movement.

Fixed-focus Box Cameras.—*The Univex Model A Camera.*—This compact little camera is made by the *Universal Camera Corporation, 32-46* West *23rd* St., New York City, and it sells for the small sum of *$1.00*. It has a single meniscus, *two-focus* or *two-point setting* lens, as it is called, a snap-shutter and an eye-level finder. It takes a $\frac{5}{8}$ *x 1*-inch picture and as this is made on a fine-grain film it can be enlarged up to *8 x 10* inches and still retain its detail. You can take eight pictures on each roll of film and the latter costs only *10* cents. The film used with it is a high-speed, panchromatic one and this latter quality renders the colors of the subject in its true tonal values.

The Baby Brownie.—Although this modernage-designed little camera costs only *$1.00,* it takes good clear pictures that have considerable depth and detail in them. True the pictures are small—$1\frac{5}{8}$ *x* $2\frac{1}{2}$ inches—but they are large enough so that you can see them distinctly and, hence, put them in your album without having to make enlargements of them.

It has a single meniscus lens, a rotary snap-shot shutter and an eye-level direct-view finder that folds flush with the top of the camera when it is not in use. Naturally it is of the fixed-focus type with a range of from *5* feet to infinity.[12] To load the camera you have only to take off the top to which the film-winding mechanism is attached and put a roll of *No. 127* vest-pocket film in it. This will give you eight pictures with a single loading.

The Six-16 and Six-20 Brownies.—These little cameras are the evolved products of the first of the *Eastman Kodaks,* and they come in two models, namely (*a*) the *Six-16* and (*b*) the *Six-20.* They differ only in the size of the pictures they take, the former taking $2\frac{1}{4}$ *x* $3\frac{1}{4}$-inch pictures, and costing *$3.00,* while the latter takes $2\frac{1}{4}$ *x* $4\frac{1}{4}$-inch pictures and costs *$3.75*. Each one has a single achromat meniscus two-focus lens, the first setting of which gives a sharp focus at from *5* to *10* feet, and the second from *10* feet or more from the camera. Each camera is fitted with two

[12] In photographic parlance *infinity* means any distance that is over *100* feet from the camera.

magnifying finders so that you can take either vertical or horizontal pictures with it. A picture of one of them is shown in *Fig. 42*.

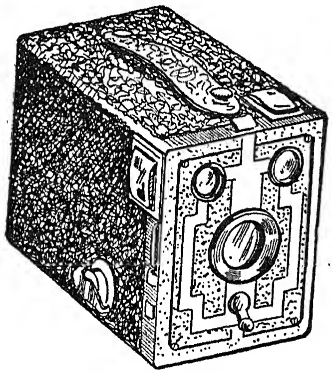


FIG. 42.—THE SIX-16 BROWNIE CAMERA
(Fixed-focus lens.)

The Bullet Camera.—This is an entirely new idea in a fixed-focus camera in that it is streamlined and can readily be carried in your pocket. When you are not using it the front of the lens is flush with the camera, and to get it ready for action you have only to give the angular screw mount a single turn when the lens is brought into the picture-taking position.

This done you simply sight the object through the eye-level finder and press the shutter release. After you have made the snap-shot you turn the lens mount back and fold up the finder when it once more takes on a smooth, compact and pocket-fitting shape. It takes eight *1⅝ x 2½*-inch pictures which you can enlarge up to *8 x 10* inches without loss of detail. The price of it is *$2.85*.

The Agfa Ansco Box Camera Family.—A pair of twin cameras are included in this family, and they are known as (*a*) the Cadet, (*b*) the Cadet Special, (*c*) the Shur-Shot, and (*d*) the Shur-Shot Special. Both the *A-8 Cadet* and the *A-8 Cadet Special* are fitted with a single meniscus lens and have a one-way shutter release. They both take eight *1⅝ x 2½*-inch pictures and the only difference between them is that the former has two ground glass waist-line

finders and costs *$1.00,* while the latter has a direct view eye-level finder, and it costs *$1.50.*

The *B-2* and *D-6 Shur-Shot* cameras each have an achromatic meniscus lens, a diaphragm with two openings, a positive acting shutter, a pair of ground-glass finders and a built-in yellow filter. Special *wings* are built into the camera which enable you to take half-size or full-size pictures on the same film. The *B-2* camera takes *eight* $2\frac{1}{4}$ *x* $3\frac{1}{4}$, or *sixteen* $1\frac{5}{8}$ *x* $2\frac{1}{4}$-inch pictures, and the price of it is *$2.50,* while the *D-6* camera takes *eight* $2\frac{1}{2}$ *x* $4\frac{1}{4}$, or *fifteen* $2\frac{1}{8}$ *x* $2\frac{1}{2}$-inch pictures, and it sells for *$3.00.*

Finally, the *B-2* and *D-6 Shur-Shot Specials* are built exactly like the two foregoing models except that they are fitted with a pair of magnifying finders. They also make the same size pictures as the foregoing, and the *B-2,* which takes the smaller size, costs *$3.40,* while the *D-6,* which takes the larger size, is priced at *$4.15.*

The Fixed-focus, Folding Cameras.—To combine the ease and certainty of operation of the fixed focus box camera with the extreme portability of the focusing folding camera, the *fixed-focus folding camera* was invented. To take a picture with any of them you need only to press a button when the front that carries the lens snaps out and into position, then sight the subject through the finder and press the shutter release when the exposure is made and the picture is taken. These cameras are made in many styles the chief ones of which in this country are the Eastman *Kodaks* and the Agfa Ansco *Readysets* and *Plenars.*

The Kodak Fixed-focus Folding Cameras.—The Eastman Company makes an even half-dozen models of these cameras. The *Jiffy V.P.* (vest pocket) *Kodak* is fitted with an achromat doublet lens, *i.e.*, one that has two components, and it has a relative aperture of *f.16,* a built-in shutter and a folding, direct-view eye-level finder. It takes *eight* $1\frac{5}{8}$ *x* $2\frac{1}{2}$-inch pictures, weights *10* ounces and sells for *$5.00.*

The *Kodak Bantam* is so small that you can hold it in the palm of your hand and yet it takes *eight* $2\frac{3}{4}$ *x* *4*-inch pictures. You can get one fitted with an anastigmat *f.5.6* lens for *$16.50,* or one with an *f.4.5* lens for *$27.50.* It has a snap-shot and time-action shutter and an eye-level finder. The fixed focus and fixed shutter

speed eliminates the problems that the beginner is confronted with in adjustable focus and variable speed cameras.

The *Jiffy Kodaks, Series II.*, are made in two styles, namely the *Six-20* which takes a $2\frac{1}{4}$ *x* $3\frac{1}{4}$-inch picture and costs *$9.00*, and the *Six-16* which takes a $2\frac{1}{4}$ *x* $4\frac{1}{4}$-inch picture and sells for *$10.00*. Both of them are fitted with a *two-focus lens, i.e.*, one that has a mount which can be turned so that it will focus sharply for distances of from *5* to *10* feet and for *10* feet to infinity. They have built-in shutters with snap-shot and time action, a three-opening stop, a finger release and *brilliant* (magnifying) waist-level finders for taking either vertical or horizontal pictures.

The *Junior Kodaks, Series II.*, are also made in two styles, the *Six-20* which takes $2\frac{1}{4}$ *x* $3\frac{1}{4}$-inch pictures, and the *Six-16* which

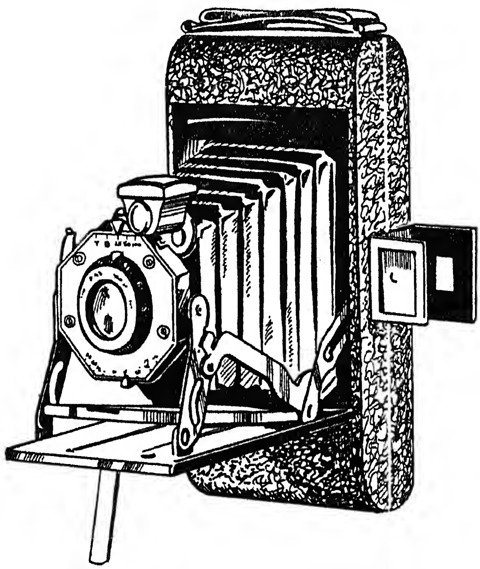


FIG. 43.—THE JUNIOR FOLDING KODAK

(Fixed-focus lens.)

takes $2\frac{1}{2}$ *x* $4\frac{1}{4}$-inch pictures. The *Six-16* is fitted with a single lens, and a snap-shot and time shutter and it sells for *$11.00*; one with an achromat lens and a shutter with speeds up to 1/100 of a second costs *$13.50*, while one with an anastigmat *f.6.3* lens and a shutter with speeds up to 1/100 of a second is listed at

$15.75. The *Six-20*'s can be had with any one of the above three kinds of lenses and shutters for *$9.25*, *$11.75*, and *$14.00* respectively. A *Junior Six-16* camera is pictured in *Fig. 43*.

The Agfa Fixed-focus Folding Cameras.—The *Agfa Ansco Corporation* makes five models of fixed-focus cameras, and two of these are called *Readyset* and three of them are known as *Plenax*. The *PB-20 Readyset* camera takes *eight* $2\frac{1}{4} x 3\frac{1}{4}$-inch pictures, and costs *$8.50*, while the *PB-16* takes *eight* $2\frac{1}{2} x 4\frac{1}{4}$-inch pictures and it sells for *$9.50*.

The *Plenax* camera is made in two sizes and three models, and the first of these is the *PB-20* which takes *eight* full-size $2\frac{1}{4} x 3\frac{1}{4}$, or *sixteen* half-size $1\frac{5}{8} x 2\frac{1}{2}$-*inch* pictures. The second size is the *PD-16*, and this one takes *eight* full-size $2\frac{1}{2} x 4\frac{1}{4}$, or *fifteen* half-size $2\frac{1}{8} x 2\frac{1}{2}$-inch pictures. The three models of these two sizes are the Plenax *Antar*, which has time and instantaneous shutter speeds, the *PB-20* size, and which sells for *$12.00*, and the *PD-16* size for *$14.00*.

The Plenax *Tripar* and Plenax *Hypar* models have an *f.6.3* anastigmat lens and a shutter that gives speeds of $1/25$, $1/50$ and $1/100$ of a second. The *Tripar PB-20* size is listed at *$14.50*; the *PD-16* size at *$16.50*; the Hypar *PB-20* size sells for *$18.00*, and the *PD-16* size for *$20.50*.

The Zeiss Ikon Fixed-focus Folding Cameras.—These cameras can be had in many models and at greatly varying prices. They go by the trade name of *Ikomat*, are all of the two-focus, or two-point setting lens kind. The cheapest of these cameras are the *C* and *D* models, the first of which takes $2\frac{1}{4} x 3\frac{1}{4}$, and the second $2\frac{1}{4} x 4\frac{1}{4}$-inch pictures. They are fitted with *f.6.3* anastigmat lenses and have shutters with speeds of from $1/25$ to $1/100$ of a second. The *C* camera costs *$19.00* and the *D* camera is listed at *$25.00*.

The *C* and *D Special* models take the same size pictures as the straight *C* and *D* cameras cited above but they are fitted with *Tessar f.4.5* lenses and *Compur* shutters. The *C Special* with an *f.4.5* lens costs *$61.00*, and with an *f.3.8* lens, *$72.50*; while the *D Special* with an *f.4.5* lens sells for *$61.50*. Other Ikon cameras can be had at varying prices up to *$374.00* for the *Universal Jewel*.

The Focusing Folding Cameras.—The *3A Kodak Series II* has a *sliding focusing movement*, and hence you simply slide the front in the guide on the bed that carries the lens to and fro in order to focus it. It is fitted with a Kodak anastigmat lens that has an aperture of either *f.4.5*, or *f.6.3*. The *f.4.5* lens is fitted with a *Compur* shutter that has eight speeds, the highest being 1/200 of a second, while the *f.6.3* lens has a shutter with four speeds, the highest being 1/100 of a second. The price of the camera with an *f.4.5* lens is *$75.00*, while with the *f.6.3* lens it is *$45.00*. It takes a picture $3\frac{1}{4} \times 5\frac{1}{2}$ inches which is large enough for all ordinary purposes without enlarging it.

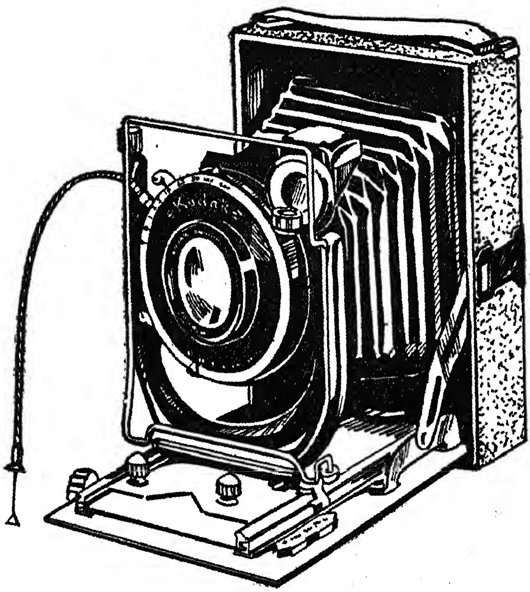


FIG. 44.—THE KODAK RECOMAR CAMERA
(Rack and pinion focusing movement.)

The *Kodak Recomar*, see *Fig. 44*, is made in two sizes and these are known as *18* and *33*. They are exactly alike in all respects except that the *18* takes $2\frac{1}{4} \times 3\frac{1}{4}$-inch pictures and the *33* takes $3\frac{1}{4} \times 4\frac{1}{4}$-inch pictures. They have a *rack* and

pinion-focusing movement, and are fitted with a ground-glass focusing screen, as well as a wire-frame, eye-level and a brilliant waist-level finder. Both have a double extension bed and bellows which enables you to make close-ups, and they are fitted with a *Kodak* anastigmat *f.4.5* lens, a *Compur* shutter and a built-in finder. Each one has three combination plate and cut-film holders, with a film-pack adapter. The price of the *18* is *$54.00,* and that of the *33* is *$63.00.*

The Folding View Camera.—If you are going to make a business of taking architectural, interior, or commercial pictures, or portraits in homes, this is the kind of a camera you want. The kind of a lens you use with it will depend largely on the class of work you are going to do, but to get the best results it must, of course, be an anastigmat. The two chief makes of view cameras in this country are (*1*) the Eastman and (*2*) the Agfa Ansco.

Now while there are various minor differences in the construction of them, both have a rising and falling front, reversible back, vertical and horizontal swing back, double or triple extension bed, and front or back focusing adjustment, and the latter is operated by a rack and pinion movement. They fold up for carrying, and when open the front and back can be brought closely enough together so that a wide-angle lens can be used with them.

The *Eastman Company* makes several kinds of view cameras, to wit, (*a*) the View Camera, *33A;* (*b*) the View Camera, *No. 2D;* (*c*) the Century Universal, and (*d*) the Cirkut *Nos. 6* and *10.* The *View Camera 33A,* takes a *5 x 7* picture, and the reversible back is fitted with a cut-off board which enables you to make two exposures on the plate or film. The bellows has a draw of *13* inches which enables you to make close-ups. The price of the camera with one plate or film holder, but without the lens, is *$29.00.*

The *View Camera No. 2D,* is made in two sizes, *i.e.,* taking *5 x 7* and *8 x 10* pictures. They are otherwise identical, and have a removable lens board, a cut-off board for making two or four exposures on a single plate or film and a sliding tripod block; by means of the latter you can center the lens directly over the

tripod and, it follows, take a series of exactly matched panoramic negatives. The bellows of the *5 x 7* camera has a draw of *23* inches and that of the *8 x 10* camera, a draw of *29½* inches. The price of the former without the lens is *$60.00* and that of the latter is *$70.00.*

The *Century Universal* takes *8 x 10* pictures and is made chiefly for the professional commercial photographer. It has every conceivable adjustment that is needed for extreme wide-angle or long-focus work, and can be used for photographing high buildings, interiors in cramped spaces and from difficult angles, balcony and bird's eye views, and non-perspective copying and reproduction. It has a bellows draw of *30* inches and folds compactly enough so that you can use a wide-angle lens having as short a focus as *5* inches with it. The price of it without the lens is *$91.00.*

Finally the *Cirkut* is a revolving camera that is particularly adapted for taking large groups, landscapes, construction work, etc. Negatives can be made with it that are *6* inches wide, it uses roll film that are *5, 10* or *15* feet long, and it will take pictures up to *360* degrees, *i.e.*, a complete circle. It is fitted with an *f.7.7* anastigmat lens, a tripod with a special head that has scales which indicate the length of the negative necessary to include all of the group or landscape.

The way it operates is like this: a spring motor revolves the camera in a horizontal plane and this winds up the film at the same time, the speed of which is controlled by a governor. The speed is adjusted by a dial and pointer, and the exposures range from $\frac{1}{2}$ to $\frac{1}{12}$ of a second for any part of the negative. A release starts and stops the exposure, and an indicator shows how much of the film has been used. The Cirkut camera and complete outfit is listed at *$293.50.*

The Agfa Ansco *Universal Junior View Camera* is a semi-professional camera and it is shown in *Fig. 45.* It has a rack and pinion focusing movement and the minimum focal length from the ground glass to the lens is *3* inches and the maximum length is *9⅛* inches. It takes a *3¼ x 4¼*-inch picture, and has a double plate holder and a double cut-film holder. A supplementary long lens board can be used for taking distant land-

scapes. The price of the camera without a lens or shutter is *$30.00*, or with a Wollensak Velostigmat *f.6.3* lens and shutter is *$37.50* additional.

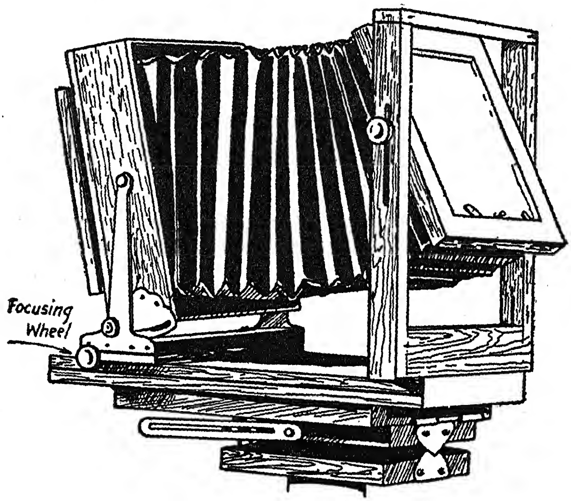


FIG. 45.—THE AGFA UNIVERSAL JUNIOR VIEW CAMERA
(Rack and pinion focusing movement.)

The Stereoscopic Camera.—In the good old South Bend days a stereoscope and its concomitant stereoviews were an essential adjunct to the marble-top parlor table of every well-regulated home. As you may or may not know, by placing a view in the scope and looking through the latter, the former will stand out in three-dimensions exactly as though you were observing the actual scene.

Now while stereophotography is almost a forgotten art, the pictures are just as beautiful and intriguing now as they were away back there in the *nineteenth* century and so if you are looking for a hobby that is at once interesting and fascinating, you cannot do better than to take up this three-dimensional branch of it. There are only a few stereocameras on the market and chief among them are (*1*) the Duo-Vex, (*2*) the Elo, and (*3*) the Heidescope.[13]

[13] If you have a *Leica* camera you can get a stereo-attachment for it and this will be described presently.

The *Duo-Vex* stereocamera consists simply of a pair of Univex cameras mounted on a base, and it takes twin pictures each of which are $1\frac{1}{4} \times 1\frac{1}{2}$ inches. A viewing device, two rolls of film and a package of *12* mounts come with it, and the complete outfit costs but *$3.15*.

The *Elo* stereocamera, which is shown in *Fig. 46,* takes $2\frac{1}{4} \times 2\frac{1}{4}$-inch pictures on a standard roll film. It has a pair of double *f.11* lenses, an eye-level wire finder, a waist-level reflecting finder, and a trigger and cable release. The price of it, including a viewer, is *$12.50*. The *Heidescope* stereocamera is

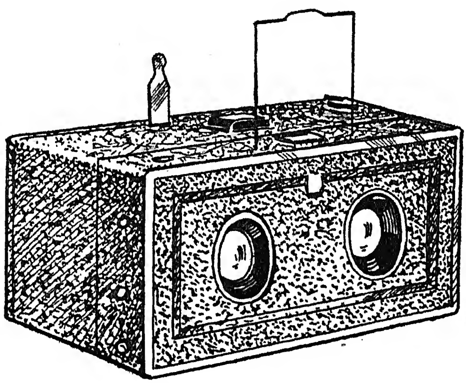


FIG. 46.—THE ELO STEREOCAMERA
(Fixed focus.)

made in two sizes and both of these are fitted with Zeiss *f.4.5* lenses, a reflecting focusing finder, a plate magazine and a film adopter. The smaller size, which takes $1\frac{3}{4} \times 4\frac{1}{4}$-inch pictures, sells for *$230.00,* while the larger one, which takes $2\frac{1}{4} \times 4\frac{3}{4}$-inch pictures, sells for *$270.00*.

Kinds of Press Cameras.—The two chief kinds of folding *press cameras* are (*1*) the Speed Graphic and (*2*) the Graflex, and both of them have a rack and pinion focusing movement. The *Speed Graphic*[14] is, as its name indicates, a high-speed

[14] Both the *Speed Graphic* and the *Graflex* are made by the *Folmer Graflex Corporation,* Rochester, New York.

camera and you focus it with (*a*) a distance scale or (*b*) a ground-glass screen.

With the *distance scale* you can use an eye-level wire frame and peep-sight finder which makes it easy to follow a moving subject, or if it is stationary you can use the waist-line magnifying finder; where the time required for focusing is not an element of importance you can use the ground-glass screen.

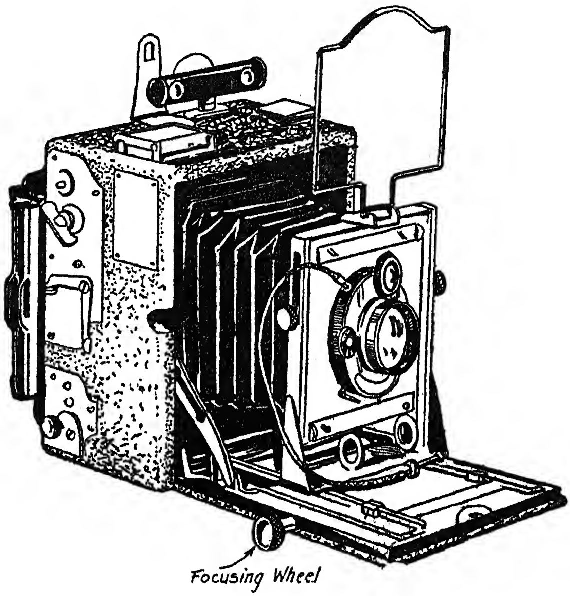


FIG. 47.—THE SPEED GRAPHIC CAMERA

(Rack and pinion focusing movement.)

The camera, which is shown in *Fig. 47*, is fitted with an anastigmat *f.4.5* lens, a focal-plane shutter giving *24* speeds of from $\frac{1}{10}$ to $\frac{1}{1000}$ of a second, and time exposures, and either a Graphic back which takes a plate holder, or a film-pack adapter. By using a between-the-lens shutter and a *photo-flash synchronizer,* which will be described in another chapter, either *still* or *action* pictures can be made at night. The Speed Graphic can be had in two sizes and these take $3\frac{1}{4} x 4\frac{1}{4}$ and $4 x 5$ pictures

respectively. The smaller size is listed at *\$75.00*, and the larger one at *\$130.00*.

The *Graflex* is, to my way of thinking, the greatest camera of them all, and when I say you can *do anything with it* in the way of taking pictures I mean just that. Of course the chief advantage of it is that it gives you a direct full vision image—in other words when you look into the focusing hood you see the picture you are going to take clear, full sized and right-side up to the very split second of the exposure. While you are focusing and composing the picture the image of your subject is projected on the ground glass screen with hair-line sharpness and with true light and tone values.

There are several different models of the *Graflex,* the smallest of which takes *2¼ x 2½* and the largest *5 x 7* pictures. I can't go into the constructional details of these cameras but you can get a very good idea of how they are made and work from the picture shown in *Fig. 48*, which is cut away so that you can see the interior parts of it.

Only the fastest anastigmats are supplied with these models; usually an *f.4.5* or an *f.3.5* lens is used with it but for exceedingly high speeds an *f.2.9* lens is employed. The standard lens that is used with the Graflex is interchangeable with the telephoto lens. The price of the *2¼ x 2¼ National Graflex* with an *f.3.5* lens is *\$82.50,* while an *f.6.3* telephoto lens costs *\$55.00* additional. The *3¼ x 4¼, 4 x 5,* and *5 x 7 Graflex Series B* with *an f.4.5* lens, ranges in price from *\$85.50* for the smaller size to *\$178.50* for the larger size, while a telephoto lens for them costs from *\$107.00* to *\$179.50* additional.

The *Auto Graflex* with revolving back is made in *3¼ x 4¼* and *4 x 5*-inch sizes, and these are listed at *\$165.50* and *\$242.50* respectively with a Kodak anastigmat *f.4.5* lens, and with *f.4.5* lenses of other makes the prices run on up to *\$208.00* and *\$264.50*. Finally, the *5 x 7 Home Portrait Graflex* with a Kodak anastigmat *f.4.5* lens sells for *\$350.00,* and with a Zeiss *Tessar f.3.5* lens for *\$512.00,* while the price of this camera varies between these extremes where lenses of other makes are supplied with it.

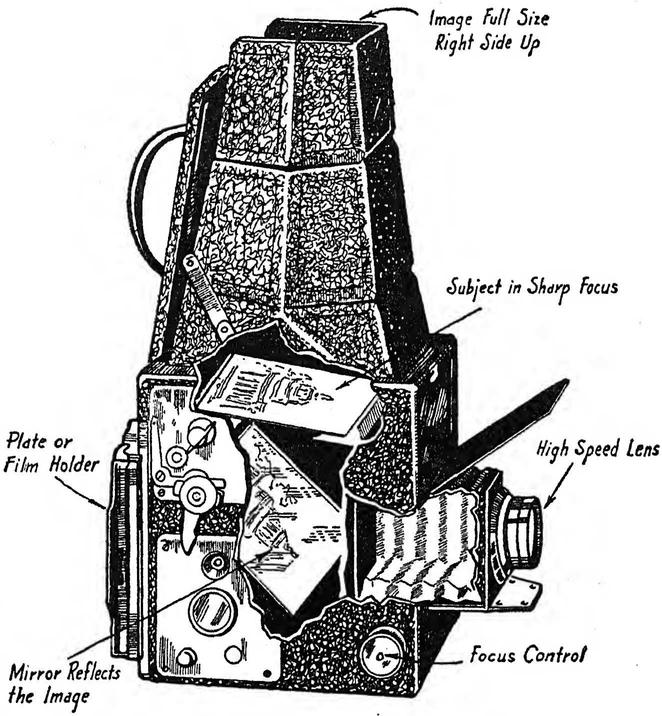


FIG. 48.—THE GRAFLEX CAMERA
(Rack and pinion focusing movement.)

Miniature and Candid Cameras.—While any camera that is fitted with a fast lens and a high-speed shutter and which takes a picture that is not larger than $2\frac{1}{2} x 2\frac{1}{2}$ inches is called a miniature camera, or *minicam*, the term should be properly applied only to those cameras which use either a half- or a full-size moving-picture film, *i.e.*, a *16mm.* or a *32mm.* film.

At the present time we hear a great deal about the *candid camera*, and this term means any camera with which you can take a picture of a person while he is unaware of the fact that you are doing so—with the result that you catch his facial expression as it is and not as it would otherwise vainly be if he knew it. A candid camera is then, in the last analysis, a miniature camera.

The chief miniature cameras that are used in this country are (*1*) the Argus, (*2*) the Leica, (*3*) the Contax, (*4*) the Kodak Retina, and (*5*) the National Graflex Series II. These cameras are focused by means of (*a*) the two-point setting lens mount, (*b*) the helical revolving lens mount, and (*c*) the rack and pinion movement. If you are interested in the various foreign makes of miniature cameras write to *George Murphy, Incorporated, 57* East *9th* St., *New York City,* and to the *Bass Camera Company, Incorporated, 179* West Madison St., Chicago, Illinois, who are the selling agents for nearly all of them.

The Argus Miniature Camera.—This is the lowest-priced true miniature camera that I know of, and it is made by the *International Research Corporation,* of Ann Arbor, Michigan. It has an *f.4.5* anastigmat lens, with a two-point setting mount so that close-ups can be made, and a shutter that gives time exposures and split-second speeds of $1/25$ to $1/200$ of a second.

It uses a regular *35mm.* perforated moving-picture film and takes *36* pictures with each loading. With it you can indulge in all of the latest photographic hobbies, such as taking pictures in natural color, by infra-red rays, and snap-shots by artificial light. It costs only *$12.50.*

The Kodak Miniature Cameras.—The two chief Kodak miniature cameras are (*1*) the Vollenda, and (*2*) Retina. The *Vollenda* takes *sixteen* $1\frac{3}{16}$ *x* $1\frac{9}{16}$-inch pictures with one loading, it is fitted with an *f.3.5* anastigmat lens and a shutter with nine speeds up to $1/500$ of a second. It focuses from *3* feet to infinity by means of a helical revolving lens mount, has a depth-of-focus scale and an eye-level finder. The list price of it is *$44.50.*

The *Retina* takes *thirty-six* *1 x* $1\frac{1}{2}$-inch pictures, has an anastigmat *f.3.5* lens and a shutter with speeds up to $1/500$ of a second. It is fitted with a helical revolving lens mount, an eye-level finder, a depth-of-focus scale, and an exposure counter. It is made in two styles and these differ only in finish, one of which sells for *$44.50* and the other *$57.50.*

The Zeiss Contax Cameras.—*Carl Zeiss, Incorporated,* make a number of very fine miniature cameras but the two chief ones are (*1*) the Universal Contax and (*2*) the Contaflex. There are

three models of the *Universal Contax* and all of them can use any one of the fourteen interchangeable Zeiss lenses, whose apertures range from *f.1.5* to *f.8,* and which I have described in Chapter III. All of them are alike in general design, construction, and operation, and all take *36* pictures on a *35mm.* roll film.

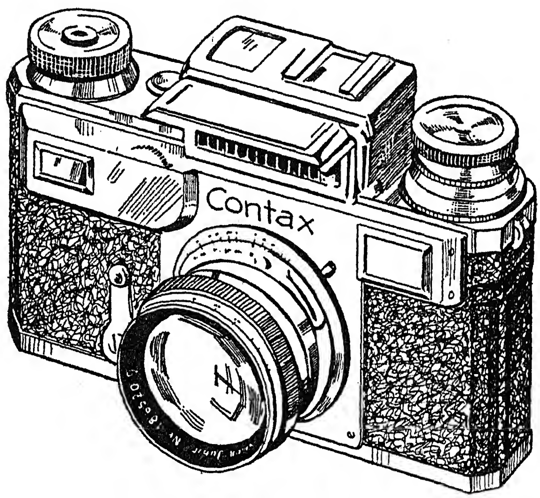


FIG. 49.—THE ZEISS CONTAX MINIATURE CAMERA
(With automatic focusing lens mount.)

The *Contax I* is an inconspicuous black camera which is a good one to take candid pictures with unobserved. It has shutter speeds of ½ to 1/1000 of a second. *Contax II* is a chromium-finished camera with a top speed of 1/1200 of a second and it includes a combined range and a view finder; while the *Contax III* is a chromium-finished camera, and has a combined range and view finder like the *Contax II,* but it also has a sensitive, built-in photoelectric exposure meter with which you can get an instant and accurate control of focus and exposure, and both of which are highly important factors in making good negatives.

The prices of the *Contax I, II,* and *III* without the lens are *$97.00, $140.00,* and *$190.00* respectively. The Contax with a Tessar *f.3.5* lens costs *$145.00,* and the *Contax III* with a Sonnar

f.1.5 lens is *$370.00*, while the prices in between these two extremes vary with the model of the camera and the speed of the lens that is used with it. The *Contax III* is pictured in *Fig. 49*.

The *Contraflex* miniature is a reflex camera like the *Graflex*—only different. It is fitted with a separate focusing lens, mirror and ground-glass screen and this gives an image of the actual field you are going to take the picture of but the size of it is enlarged to $1\frac{3}{8} \times 2\frac{7}{8}$ inches so that you can see it more clearly and, it follows, focus it more accurately.

It takes *36* pictures $\frac{15}{16} \times 2\frac{3}{8}$ inches to a roll of film, and it is fitted with either an *f.2.8* or an *f.2* lens, and six interchangeable lenses for various purposes can be used with it if you so desire. It has a focal plane shutter with *11 speeds* up to $\frac{1}{1000}$ of a second. The price of the *Contraflex* with a *Tessar f.2.8* lens is *$321.00*, and with a *Sonnar f.2* it costs *$435.00*.

The Leitz Leica Cameras.—E. Leitz, Incorporated, also make a number of very fine miniature cameras and of these there are three chief models, namely (*1*) the Model E, (*2*) the Autofocal, and (*3*) the Single Exposure camera. All of these cameras can use any one of the *14* different interchangeable lenses and they are focused by means of a helical revolving lens mount.

All of the Leitz lenses are anastigmats and have apertures ranging from the extremely high-speed *f.1.5 Xenon*, which has a minimum focusing distance of *3½ feet*, and costs *$180.00* to the *Elmar f.6.3*, which is a distance light-weight lens for landscape photography, with a minimum focusing distance of *10* feet, and which costs *$58.00*.

In the *Model E* camera the lens is focused by hand, *i.e.*, by rotating the lens mount. It is fitted with a focal-plane shutter, with speeds of from $\frac{1}{20}$ to $\frac{1}{500}$ of a second, and a horizontal detachable range finder. When fitted with an *Elmar f.3.5* lens it costs *$94.50*.

The *Autofocal Models D, G* and *F* are fitted with any one of the various lenses you want, they have focal-plane shutters with speeds of from *1 to* $\frac{1}{1000}$ of a second, a built-in focusing range finder and a *1½ x* magnifying eyepiece for the range finder. As you adjust the range finder for distance the lens is automatically focused, and the way this is done will be explained

in the following chapter. The Autofocal camera costs from *$81.00* without the lens to *$300.00* when fitted with a *Xenon f.1.5* lens.

The *Autofocal Model FF* has magazines that holds *33* feet of film and, hence it has an exceedingly large capacity—enough for *250* exposures. In all other respects it is identical with the Leica *Autofocal F* model. The price of it is *$186.00* without a lens, and *$234.00* with an *Elmar f.3.5* lens.

The *Single Exposure* camera is really a miniature view camera and makes only one exposure when you have to change the film. It consists of (*a*) a round body into which any one of the various Leitz lenses can be screwed, (*b*) a ground-glass screen is used for focusing and (*c*) it slides in and out of the back of the camera; it is interchangeable with (*d*) a metal film holder, which takes a single frame *35mm.* moving-picture film, *i.e,* one that is $1\frac{3}{8}$ inches wide and $1\frac{1}{2}$ inches long. A between-the-lens shutter which can be used with any of the Leica lenses comes with the camera. The price of the camera is *$27.00,* and whatever lens you use with it costs that much more.

A *Stereo Attachment* can be used with any of the above cameras for taking miniature stereoscopic pictures. It consists of a little rectangular box with a pair of opposed double prisms in it. These meet in the middle of it, and the lens mount screws into the back of the box so that the line of contact of the prisms is in the middle of the lens. The prisms split the rays of reflected light from the subject or scene into two parts when they pass through each half of the lens and this forms a separate image on the film.

Now when you take twin pictures of a subject or a scene the images are photographed the same distance apart that your eyes are and, it follows, when you look at them through a stereoscope they blend into one picture and this stands out in three dimensions, *i.e.,* length, breadth, and depth. To see the pictures with stereoscopic effect you must have a *stereo viewer* that is especially made for viewing the miniature picture. The price of the stereo camera attachment is *$39.00,* and the stereo viewer costs *$42.00* additional.

The National Graflex Series II Camera.—Don't look now but that Graflex is here again! This time it is the new miniature

National Series II, and, like its big brother, it is a folding camera with a rack and pinion focusing movement. It is a world-wide, all-purpose camera and three of them were carried by Captain Albert W. Stephens, United States Army, who was commander of the National Geographic Society—United States Army Air Corps Stratosphere Flight in *1935,* where he obtained superb film records of the upper air stratum.

The camera takes *ten* $2\frac{1}{4} \times 2\frac{1}{2}$-inch pictures, is fitted with a *Tessar f.3.5* lens and a *telephoto f.6.3* lens which are interchangeable. It has a focal-plane shutter with eight speeds ranging from $1/30$ to $1/500$ of a second with a quick change-over device for time exposures. Two built-in cable release sockets permit the use of an accessory *self-timer* and a *delayed exposure device* gives controlled speeds ranging from $\frac{1}{2}$ a second to *10* seconds. Finally, it has a built-in *exposure guide* which gives the correct shutter speed and lens setting for all instantaneous exposures, and a built-in micro-focuser assures microscopic accuracy in focusing.

The DeVry Walkie Snap or Actionette Camera.[15] —This camera is a hybrid, having the characteristics of both the miniature and the moving-picture cameras, and yet it is far removed from either of them. It is a half-amateur, half-professional camera and it was evolved, and is designed and constructed, solely for money-making purposes, so if you want to get in on a new and successful photographic stunt now is your one big chance.

The scheme consists of taking candid shots of passers-by on the street, at sporting events, fair grounds, carnivals, in front of theaters—in fact any and everywhere that crowds foregather. As each person comes within the ken of your lens you snap him and then hand him a reply envelope. In the envelope is an identification card with a serial number on it, as shown in *Fig. 50A.*

When the card and the remittance it calls for is mailed to you, you make a post-card enlargement of the picture you have snapped and mail it to your customer. As you make each ex-

[15] This camera is sold by the *Bass Camera Company, 179* West Madison St., Chicago, Illinois.

Nº 20779 D

This No. Identifies Your Picture
Copy It!

CAUGHT IN THE ACT!

YOUR PICTURE HAS JUST BEEN TAKEN
By a Licensed Cameraman!
SEE YOURSELF AS OTHERS SEE YOU

Simply Print Your Name and Address in the space below — Insert 25c —Enclose in self-addressed envelope—no stamp necessary—Deposit in any U. S. Mail Box. A Beautiful Post Card Enlargement of You in Action! They are New! The Latest Sensation! You Will Like Them! Unposed Pictures Please Most!

HOLLYWOOD ACTIONETTES
1110 N. Van Ness Ave. Hollywood, Calif.

Name (print) ....

Street (print) ....

City .... State ....

Your Money Back If Not Satisfied

THE U. S. MAILS PROTECT YOUR QUARTER!

Coin or Stamps
Place 25c Here
Send 50c for 3

FIG. 50A.—THE IDENTIFICATION CARD

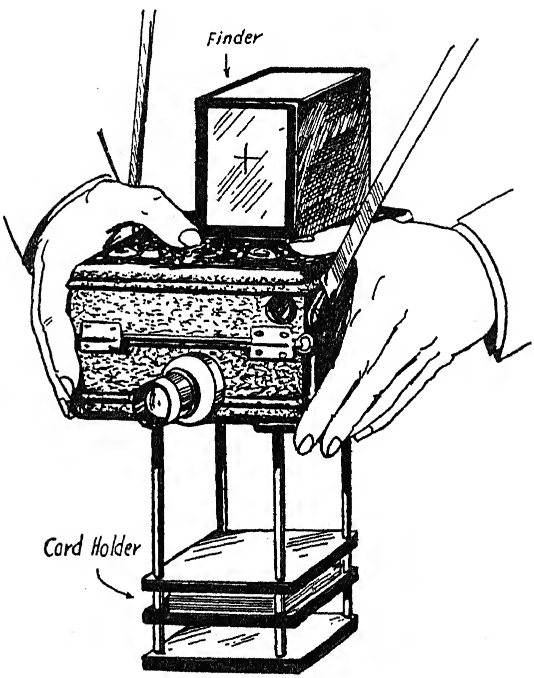


FIG. 50B.—THE DEVRY WALKIE SNAP OR ACTIONETTE CAMERA

posure a duplicate number of the one that is on the card is recorded on the film by a small vertical lens, so that you can keep track of them.

The equipment consists of a *DeVry automatic movie camera* with an *f.3.5* lens and a large direct-view finder shown in *Fig. 50B*. The spools take a *100*-foot roll of *35mm.* film and this will make *1,600* single negatives. It is fitted with an envelop carrier and recording device, and the price of it complete is *$99.50*. *Eastman supersensitive panchromatic film* or *Super X film* can be had on daylight loading spools for *$3.50* per *100* feet; *Azo post-cards* cost less than a cent apiece in *500* lots.

You can make a gallon of Eastman *No. 76* developer for the film for *60* cents, and *Eastman No. 72* developer for the post-cards for a like amount. If you develop the film yourself—which you should do—you should have a *Steinman tank*, which sells for *$50.00*. To make post-card prints from your negatives you will need an *enlarger*, and you can get one with an *f.4.5* lens and everything complete for *$39.50*.

If only *15* per cent of those you take snap-shots of respond to your cards you will be able to make a profit; *50* per cent will net you money, while under favorable conditions your returns will be as high as *70* per cent and when it does you will have a real business.

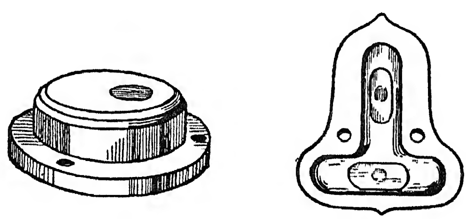
CHAPTER VIII

THE ACCESSORIES YOU NEED

I. THE MAJOR ACCESSORIES

When we speak of a camera we generally mean a *camera unit* and this includes the box or camera proper, the lens, the shutter, the ground-glass screen or finder, and the roll, cut film, or plate holder, and with this apparatus you are ready to take pictures. There are, however, a few major devices that are essential accessories to the camera if you are to take pictures of the highest order, and chief among them are (*1*) the level, (*2*) the view finder, (*3*) the range finder and (*4*) the exposure meter.

Kinds of Camera Levels.—In taking pictures with a hand camera it is not at all easy, what with focusing it and composing the subject, to tell whether it (the camera) is level or not. Usually



A. A CIRCULAR LEVEL *B.* A T LEVEL

Fig. 51.—Kinds of Camera Levels

this is done by observing the vertical lines of the image on the ground-glass screen or in the finder, and then tilting the camera a little one way or the other until they are parallel with the sides of it.

The way to eliminate all guesswork is to use a *camera level*, two kinds of which are shown at *A* and *B* in *Fig. 51*. The *circular level* consists of a little cylindrical brass cup in the top of which

is a glass disk. On top of this is some colored alcohol with a bubble on it, and over the latter is a sealed glass cover. The level is secured to the top of the camera close to the finder with a clip or screw. Now when you hold the camera so that it is perfectly level the bubble will come to rest exactly in the center of the disk.

The *T level* is formed of a pair of small brass tubes secured at right angles to each other. In each of these tubes is a sealed glass tube that is filled with colored alcohol which has a bubble in it. The level is fastened to the camera with a clip or screws, and when you hold the camera so that it is level the bubbles will come to rest in the middle of their respective tubes.

Kinds of View Finders.—The *view finder* is so important an accessory of the camera that it has all but become an integral part of it. Now in all of the earlier cameras, and in view, reflex, and studio cameras of the present time, the image of the subject is projected by the lens on a ground-glass screen the exact size the finished picture is to be and, it follows, focusing and composition becomes a comparatively simple matter.

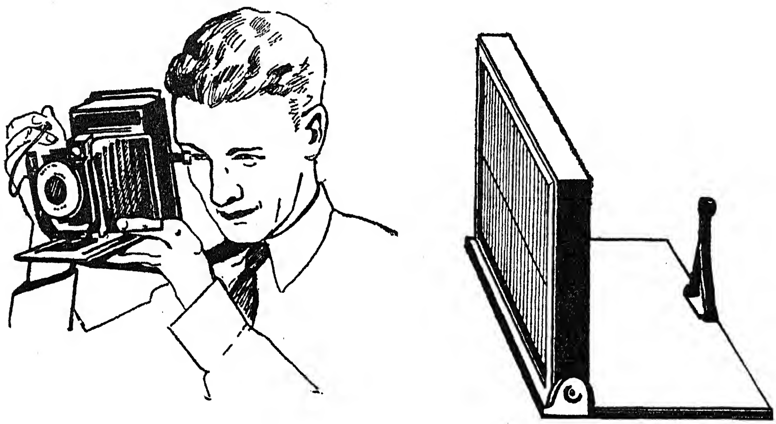
In small hand cameras of the usual kind focusing and composition by means of a ground-glass screen is not a practical scheme [1] and so the view finder, or just *finder* as it is called for short, must be used and this is attached to or is built in the camera. Now there are two chief kinds of view finders and these are (*1*) the direct view or eye-level finder, and (*2*) the indirect view or waist-level finder.

The Direct-view or Eye-level Finder.—A view finder of this kind is so called because in order to use it you must hold the camera up to and in front of your face so that your eye is on a level with the axis of the finder when you can look through it. Now there are three chief kinds of direct-view or eye-level finders and these are (*1*) the wire frame and peep-sight, (*2*) the lens and peep-sight, and (*3*) the tele-view finder.

The *wire frame and peep-sight finder,* which is shown at *A* in *Fig. 52,* is a very simple and an exceedingly good finder for the reason that (*a*) the wire frame is of the same size that the picture you are taking will be; (*b*) you use the camera at eye level

[1] The exception to this statement is the Graflex and other reflex hand cameras.

and this usually gives better results than one that is used at waist level, and (*c*) it is easier to follow moving objects.



A. THE WIRE FRAME AND PEEP-SIGHT FINDER

B. THE LENS AND PEEP-SIGHT FINDER

FIG. 52.—A COUPLE OF EYE-LEVEL VIEW FINDERS

The *lens and peep-sight finder,* see *B,* has a converging meniscus lens with crossed lines on it in front of the peep-sight, and you see the image of the object you are taking right-side up and of the exact size of the picture you are going to take. A modified form of it is the *Contax Albada* or *optical finder,* as it is called, and the principle of it and the way it works is shown at *A* and *B* in *Fig. 53.*

It consists of a front glass that is slightly silvered on the inside and a converging meniscus lens in front of it. Now by the reflection of a white line which encloses the rectangular viewing aperture the exact proportion of the picture which you are going to take is projected so that when you look in the finder you apparently see the white frame just as though it were suspended in space and which includes all of the subject that you will get on the film. In this way you are able to see a swiftly moving object before it appears in the actual position where you want to take the picture of it.

When you use a telephoto lens with your camera you must have

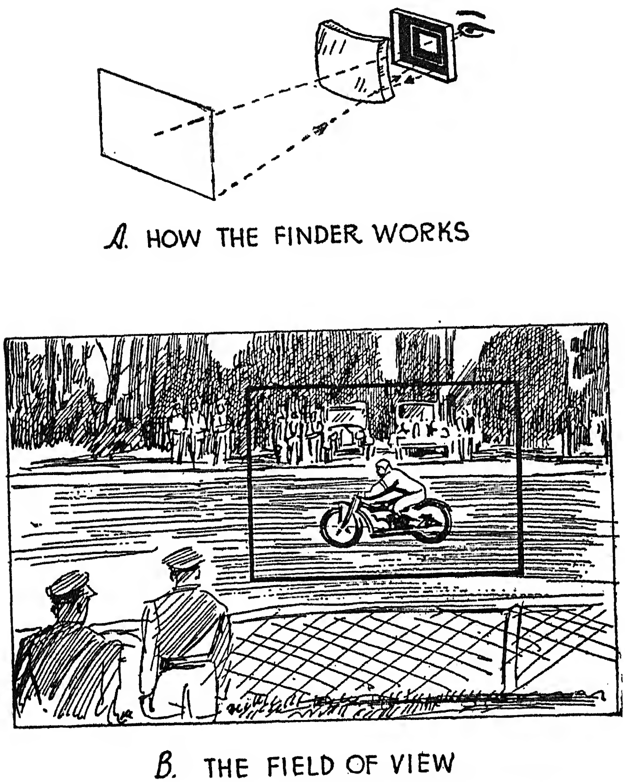


FIG. 53.—THE CONTAX ALBADA OPTICAL VIEW FINDER

a *tele-finder,* one kind of which is shown at *A* and *B* in *Fig. 54.* This finder does not have an optical system but consists of simply a tube with openings in the ends of the proper size and these are covered with disks of plate glass. It follows, then, that when you look in it you will see an unreversed image, *i.e.,* one that is right-side up and this will be the exact size of the picture you are going to take. The reason an optical system is not needed is because of the long focal length of the telephoto lens with which it is used.

Indirect View or Waist-level View Finders.—A view finder of this kind is called an *indirect finder* because the image you see is a reflected one, and a *waist-line finder* for the reason that you must hold the camera near your waist line and look down on it

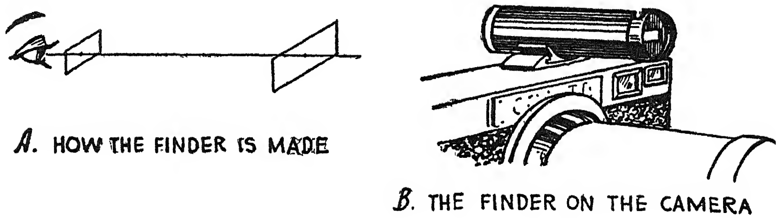


FIG. 54.—THE ZEISS TELE-VIEW FINDER

in order to see the image. There are three chief models of this type and in all of them the lens projects the image on either (*a*) a mirror, or (*b*) a prism, and these reflect it to either (*a*) a ground-glass screen, or (*b*) a converging meniscus lens.

A *mirror and ground-glass screen finder* is shown at *A* in *Fig. 55*, and this is the kind that is used in the cheapest makes of box cameras. A *mirror and meniscus lens finder* is pictured at *B*,

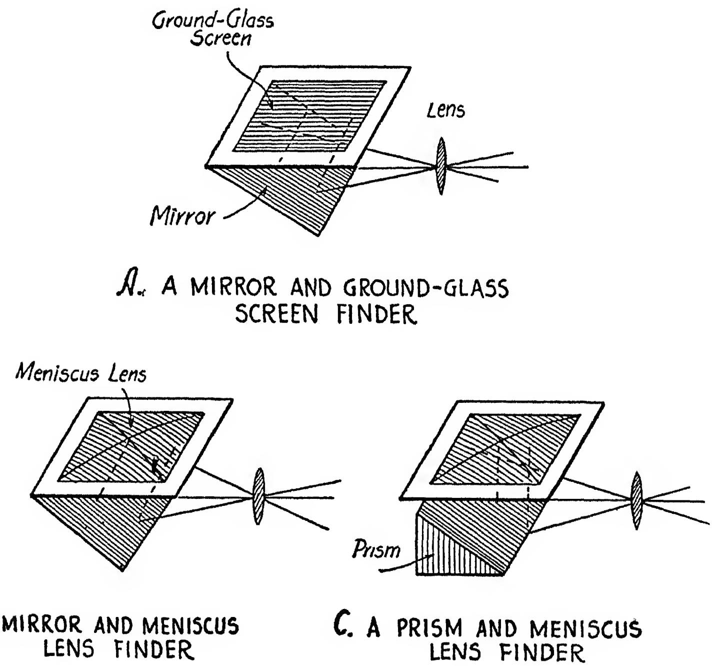


FIG. 55.—KINDS OF INDIRECT VIEW FINDERS

and this is used in the better makes of box cameras and the less expensive folding cameras. A *prism and a meniscus lens finder,* or *brilliant finder* as it is called is illustrated at *C*. A prism is used instead of a mirror because it is a far better reflector of light, and this is the reason it is used in reflecting binoculars. It gives an exceptionally brilliant and unreversed image of the subject.

The *Zeiss vertical view finder,*[2] see *A* in *Fig. 56,* likewise shows an image of great brilliance and unreversed. It is especially useful in taking pictures of children since you can hold it at a lower level

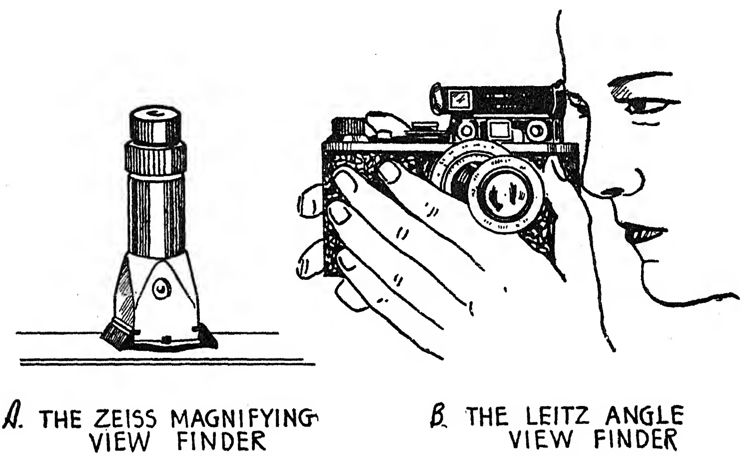


FIG. 56.—VIEW FINDERS FOR MINIATURE CAMERAS

than a horizontal one. If you want to bring it nearer your eye you can fit it with a *finder magnifier.*

The *Leitz angle view finder,*[3] see *B,* can be used at an angle of 90 degrees so that instead of looking straight ahead through it at a subject, you are apparently looking "round a corner," so to speak. This enables you to take a picture of a subject without him or her in the least suspecting it. It is also very handy for making exposures with the camera pointed upward, *i.e.,* when taking air and other sports subjects.

[2] This finder is made by Zeiss for the Contax and other miniature cameras.
[3] This finder is made by Leitz for the Leica and other miniature cameras.

Kinds of Range Finders.—A *range finder, distance meter,* or *telemetric finder* as it was originally called, is a little instrument that enables you to accurately find the distance in feet that the lens of your camera is from the subject you are going to take the picture of. The range finder was first employed in gunnery for determining the distance of the object to be hit, or *target* as it is called, but it is now extensively used, in a modified miniature form, for accurately focusing cameras that are not fitted with ground-glass screens.

The Principle of the Range Finder.—The camera range finder is constructed on the *coincidence principle,* that is, two images of the same object are brought together until your eye sees them in the same place or position. The way it is made is like this: On one side of a small tube is an eye-piece through which you view the object whose distance away in feet you want to know.

Back of it, and inside of the tube is a fixed mirror or reflecting prism that sets at an angle of 45 degrees, and at the other end of it is another mirror or another prism which can be adjusted relatively to the fixed prism by means of a mechanical movement which is attached to the focusing disk, and this is calibrated in terms of feet.

Now when you want to find the number of feet the object is from your camera you set the index that is marked on the tube, to the infinity[4] (∞)[5] mark on the focusing disk; this done you look through the eye-piece until you see two images of the object, or a separated image of it. You now turn the disk, that has the feet marked on it, which moves one of the mirrors or prisms, around until the two images, or the separate image, are superposed one on the other, and when they are accurately coincident you will see a perfect single image or a perfectly matched image according to the kind of a range finder you are using.

Range finders are made so that they can be used either (*1*) separately, that is independent of the camera, or (*2*) as an integral part of it. The kind that is used *separately* is made so that you simply hold it up to your eye, adjust it to find the range or distance and then adjust your camera according to the reading it

[4] This is any point beyond the distance of the object.
[5] This is the symbol for *infinity*.

gives. This kind can also be attached to the camera by means of an adapter, which greatly facilitates its use. In some of the miniature cameras it is mechanically coupled with the lens so that as you adjust it the latter is automatically focused.

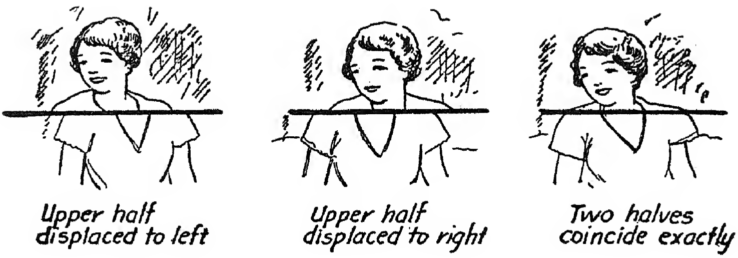
The Kodak Range Finder.—This range finder can be used with any camera that has a focusing scale, since all of them are graduated in feet. When you look through the eyepiece you see not only your subject but also a pointer and a transparent scale marked in feet. The upper half of the image will, most likely, be displaced either to the right or the left, but when you turn the knurled ring, which has the scale of feet marked on it, in the proper direction the two halves of the image move closer and closer together.

Now when the upper half of the image shows a displacement to the *left*, see *A* in *Fig. 57*, you will know that the range finder is set for a distance that is farther than the correct one. When the upper half of the image is displaced to the right, the range finder is set for a distance that is closer than the correct one, but when the two halves of the image coincide exactly, the distance is shown by the pointer and the scale that the range finder is from your subject and, it follows, the distance for which you must focus your camera. The range finder is pictured at *B*, and the way it is used at *C*.

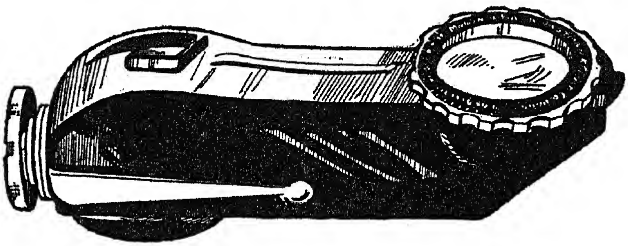
The Leitz Range Finder.[6]—This range finder can be had as a separate unit from the camera, or as an integral part of it for automatic focusing. The same optical principle is used in both kinds, that is, a double image is seen until the exact distance between the finder and the subject is had, see *A* in *Fig. 58*, but when the images perfectly coincide they will appear as a single image and the exact distance is then indicated by the scale on the finder.

The *unit range finder*, which is shown at *B*, is made in three models and these are (*a*) the *Fofer* which is used with miniature cameras from *24 x 36mm.* (about $\frac{3}{4}$ *x* *1*$\frac{3}{8}$ inches) to *4 x 6*$\frac{1}{2}$*cm.* (about *1*$\frac{1}{2}$ *x* *2*$\frac{1}{2}$ inches) and it has a scale-range of *3.5* feet to *300* feet, (*b*) the *Fonor* is used with hand cameras of *2*$\frac{1}{4}$ x *3*$\frac{1}{4}$ inches,

[6] This range finder is made by *E. Leitz, Incorporated*, *730* Fifth Ave., New York City.



A. HOW THE RANGE IS FOUND



B. THE RANGE FINDER

C. HOW THE RANGE FINDER IS USED

FIG. 57.—THE KODAK RANGE FINDER

up to *4 x 6* inches, and has a scale-range of from *1.6* feet to *150* feet, (*c*) the *Fokin* is used with standard-size film moving-picture cameras and has a scale-range of from *2* feet to *100* feet. This finder is fitted with a holder so that it can be mounted on the camera, and folded over flat without detaching it.

The way the *Autofocal range finder* works is pictured at *C*. The optical part is made like the unit range finder described above, but it is fitted with a mechanical movement; this consists of a collar which is coupled to the lens of each of the different Leica cameras, and this presses against a little roller which, in turn, actuates the prism of the range finder. The coupling between the finder and the lens is such that the lens can be changed for any other one of the series without any adjustment.

To give the double images a strong contrast, and so make it still easier to bring them into coincidence, an orange-colored filter can be fitted over one of the openings of the finder, and this gives a deep color to one of the images. To enable you to see the field to a better advantage a magnifier can be placed over the eyepiece, and this enlarges it *1½* times and, it follows, the double images can be clearly seen even when the light is poor.

The Zeiss Range Finders.—There are two kinds of these finders namely (*1*) the Super Ikonta, and (*2*) the Contameter. The *Super Iconta* is an automatic focusing range finder and it consists of a glass bar at each end of which is a prism. The bar is enclosed in a tube and a pair of lenses is mounted in front of one of the prisms as pictured at *A* in *Fig. 59*.

The range finder shows two images of the subject that is being photographed, one of which is seen directly through the near prism and the other through the prismatic lens system. Now when you turn the milled wheel it moves the prismatic lens system and brings the two images into coincidence; at the same time it automatically moves the front component of the photographic lens forth and back and so focuses it with hair-line accuracy. This range finder is intended to be used only with the Zeiss Contax miniature cameras.

The *Contameter* is a unit range finder focusing objects that are very near to the camera, and getting close-ups of such things as

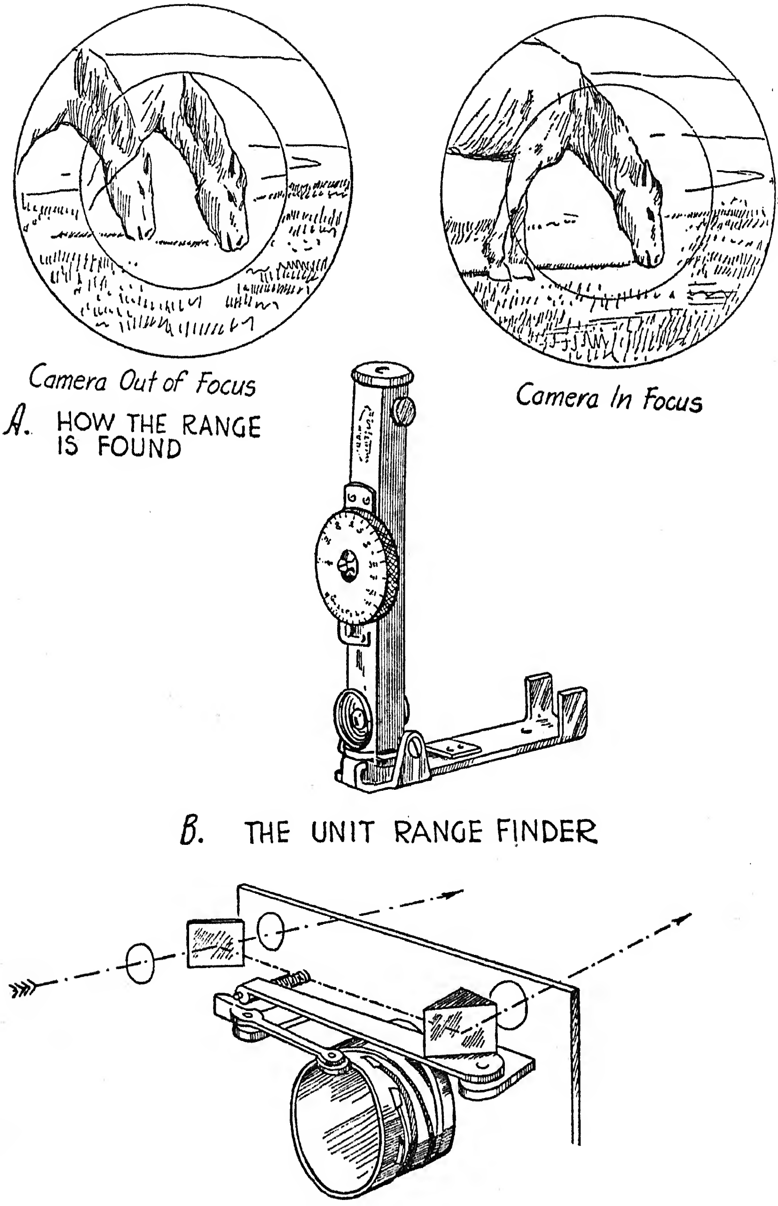
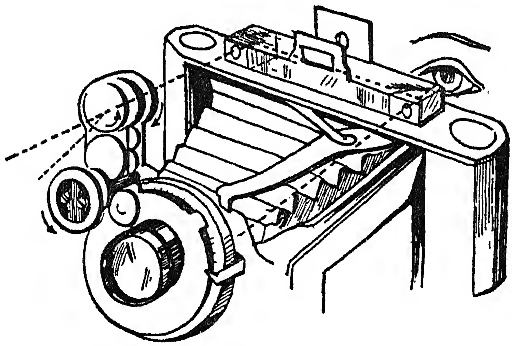


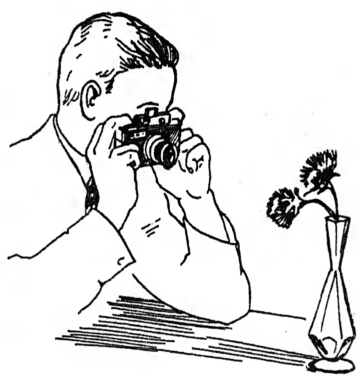
FIG. 58.—THE LEITZ RANGE FINDERS

insects and flowers, making reproductions of books, pictures, and the like, and this you do by simply holding the camera in your hand. Now instead of being adjustable for varying distances this



A. THE SUPER ICONTA RANGE FINDER

B. THE CONTAMETER ON THE CAMERA



C. THE CONTAMETER IN USE

FIG. 59.—THE ZEISS RANGE FINDERS

range finder gives only three fixed ones, namely *8, 13* and *20* inches (*20, 33, and 50 cm.*) respectively.

To make your photographic lens conform to these short distances three supplementary lenses are provided with the Conta-

meter and these fit in the lens barrel of the Sonnar *f.1.5* or *f.2* and the Tessar *f.2.8* or *f.3.5*. When you want to take a picture at any of the above distances all you have to do is to set the range finder for it and then focus the lens at infinity and either push or screw in the proper supplementary lens. The Contameter fitted to a Contax camera is shown at *B*, and the way it is used is pictured at *C*.

What an Exposure Meter Is.—As its name indicates an *exposure meter* is an instrument that measures the strength of the light and shows the length of time the plate or film should be exposed. Now before we get into the construction and operation of exposure meters let's look a little into the factors that determine the time of exposure.

The Factors of Exposure.—The chief factors that affect the time of exposure are (*1*) the intensity of the light that is reflected from the subject, (*2*) the distance the subject is from the camera, (*3*) the relative aperture of the lens, (*4*) the sensitivity of the plate or the film, and (*5*) the kind of a light filter, if one is used.

The *intensity of the reflected light* depends on the season of the year, the height of the sun and atmospheric conditions; the *distance the subject is from the camera* varies the brightness of the image to a slight extent; the brightness of the image is proportional to the square of the *relative aperture of the lens* and, it follows, the time of exposure is likewise proportional; the *sensitivity of the plate or film* varies with the make of them, since a sensitometric standard is yet to be provided for the different makes of them.

Finally, the *light filter*, since it cuts off some of the rays, increases the time of exposure, and this can be determined by multiplying the time required for a plate or film without the filter, by the *coefficient, multiplying factor*, or *filter factor*, as it is variously called, of the particular kind of emulsion used and the intensity of the light employed.

Finding the Time of Exposure.—Obviously when all of the above factors have to be taken into consideration to find the correct time of exposure it is not an easy matter, but there are three chief ways by which photographers attempt to do it, and these are (*1*) the empirical, (*2*) by using exposure tables or scales, and (*3*) by means of exposure meters.

The *empirical way* is based upon the past experience of the individual photographer and, hence, it is not very far removed from being a good guess. The *exposure tables* or *scales* are based on all of the previously cited factors of exposure and these are usually tabulated in parallel columns.

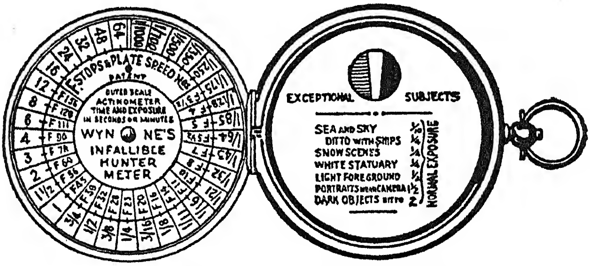
The greatest difficulty with them is that they must be calculated for a particular territory and outside of it they are practically useless, and they are also quite unreliable when the light is poor. They are, however, of considerable value to the beginner who hasn't the faintest idea of whether the exposure should be 1/25 of a second or ½ a minute. The surest way of finding the correct time of exposure is to use an *exposure meter* as this instrument really measures the intensity of the light at the time you are going to make the exposure.

Kinds of Exposure Meters.—There are three chief kinds of exposure meters and these are (*1*) the actinometer, (*2*) the photometer, and (*3*) the photoelectric exposure meter. The *actinometer* is an instrument that measures the intensity of the light by comparing an exposed sensitized paper with standard tints. The *photometer* is one that measures the intensity of the light by comparing it with another source of light and, lastly, the *photoelectric meter* measures the intensity of the light by the action of it (the light) on a *photoelectric cell.*[7]

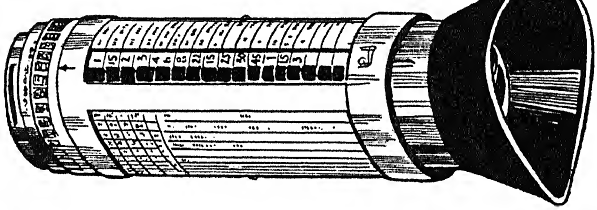
The Actinometer.—The *Wynne Hunter* exposure meter is shaped like a watch and there is only one scale to set. On the right half of it, see *A* in *Fig. 60,* is the *actinometer* with standard tints and sensitized paper while the variations for exceptional subjects are on a rotating disk which is turned by means of a button.

The left half of it is provided with two disks or scales, the smaller one of which has the stop and plate or film speed numbers marked on it, and this can be turned to set it. This disk is marked with the *f* numbers on it but if the diaphragm of your lens is marked with *U.S.* number you can change the first-named disk for one of the latter kind. The price of it is *$4.00.*

[7] The way photoelectric cells are made and work is described in detail in my book *The New World of Science,* published by the *J. B. Lippincott Company,* Philadelphia and London.



A. THE WYNNE HUNTER METER



B. THE ISTANOSCOPE

FIG. 60.—A COUPLE OF EXPOSURE METERS

The Photometer.—The *Instanoscope* and the *Bewi* exposure meters [8] are based on the photometer principle. In the Instanoscope the light values are expressed in a series of letters that are arranged in the same way as those of an optician's test chart. It is made in two models, one for regular cameras and the other for Graphic and Graflex cameras, and either kind sells for *$2.00.*

The Bewi, see *B,* shows the image you are going to take on a dark blue ground-glass screen, and on the tube is a series of numbers representing light values. It is small and light being *1⅛* inch in diameter and *3* inches long, and it weighs *2¾* ounces. It is made in two models—the *Bewi Jr.,* which costs *$7.00,* and the *Bewi Sr.,* the list price of which is *$11.00.*

[8] These exposure meters can be had of *George Murphy, Incorporated, 57* East *9*th St., New York City.

The Photoelectric Exposure Meter.—All through this book I have preached the gospel of using the exposure meter—for the only sure, safe, and sane way to take good pictures is to cut out the guess-work. By using it you can instantly find the exact time of exposure that is needed which will give the best negatives under any and all lighting conditions, and by the same token, *i.e.*, that of reducing picture failures, it will save you time, money and headaches.

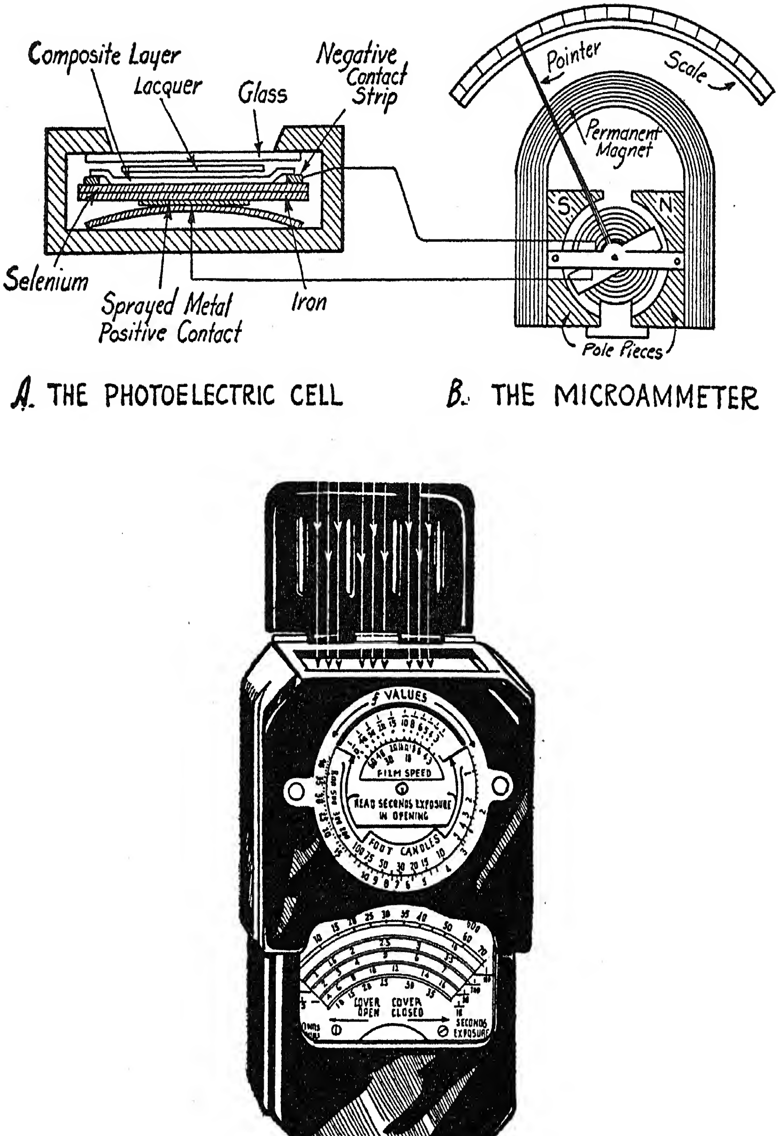
The photoelectric exposure meter is by far the most sensitive, accurate and complete one to use that has yet been devised. There are several different makes on the market but all of them consist of (*1*) a photoelectric cell, (*2*) a microammeter, (*3*) a light intensity scale, and all of these are mounted in (*4*) a small case.

The *photoelectric cell* is a light sensitive element that sets up an electric current when the light falls on it and the strength of it depends on the intensity of the latter. The photoelectric cell of the *General Electric* exposure meter consists of a layer of selenium, which is a metal, that is deposited on the surface of a thin steel plate; on the layer of selenium a transparent film of metal is deposited and this forms the negative electrode.

A like metal film is deposited on the back of the plate and this forms the positive electrode. The way the cell is made is shown at *A* in *Fig. 61*. Two like cells are used in the meter and these can be connected together either in series or in parallel depending on the intensity of the light you want to determine.

The *microammeter* consists of a permanent magnet with a pivoted movable coil mounted between its poles, and to which the needle is secured. The way it is made is pictured at *B*. The photoelectric cell and the microammeter are connected directly together as a battery cell is not needed to set up the current. The *G-E* exposure meter has a pair of *intensity light scales* and these cover two ranges, one of which is *10* times greater than the other. The upper scale is used when you want to find the intensity of bright light, and the lower are medium light levels.

When closed the meter measures a little less than $2\frac{1}{2}$ inches on the sides, and when it is open for use it is only $1\frac{5}{16}$ meters thick, $2\frac{3}{8}$ inches wide, and $3\frac{5}{8}$ inches long, and the price of it is *$19.50*.



C. THE METER READY TO USE

FIG. 61.—THE GENERAL ELECTRIC EXPOSURE METER

To use the exposure meter is the easiest thing you know for all you have to do is to remove the hood, then point it at the subject or scene you are going to take the picture of and read off the time of the required exposure. Thus, suppose the speed of the emulsion of the plate or film you are going to use is *16* then to find the exposure you have only to read the time and diaphragm setting directly on the dial at a single glance, and for other emulsion speeds you make but one setting of the calculator.

The Photoflash Lamp Unit.—Only a decade or so ago the *photoflash lamp* consisted of a contrivance that held either powder, a sheet, or a ribbon of magnesium [9] and this was fired by means of a pyrophoric spark, like that of a cigar lighter, or by an electric spark. Now when the magnesium was ignited it burned in the open air and formed a cloud of smoke that sometimes filled the room, and was not oversafe.

The new photoflash lamp consists of an electric light bulb with a sheet of crumpled magnesium in it as shown at *A* in *Fig. 62*, and when the filament is heated with a current it fires the sheet and makes a brilliant flash that lasts for about $1/50$ of a second. You can use it in any ordinary lamp socket or in a battery-operated hand flash-light unit.

The chief advantages of the new photoflash lamp over the old-style ones are (*a*) the ease of using it; (*b*) it is smokeless, and, lastly, (*d*) it is absolutely safe. When you want to use it you need only to close the circuit and this you do by simply pressing the button in the handle that contains the battery cells. To increase its effectiveness a reflector is fixed back of the bulb, as pictured at *B*.

Each lamp can be used for taking *one picture only*, and you can get it in four sizes namely, *No. 10*, which is a small one suitable for home work, will light up an area of about *12* square feet, and costs *15* cents; *No. 20*, used for general work, will cover an area of *15* feet. It can be used to advantage with other regulation lamps for taking banquets, etc., and the price of it is *25* cents. *No. 75* is a large bulb that is made especially for taking commercial photographs, and for coverage of larger areas both in-

[9] Magnesium (*Ma*) is a light, silver-white metal that burns with a dazzling white actinic light.

doors and outdoors, and it sells for 75 cents, and, lastly, the *Super Flash* which is smaller than the *No. 75* but gives 50 per cent more light. It is a good one to use where speed, intensity, and portability are of the chief importance. The price of it is 25 cents or 6 for *$1.00.*

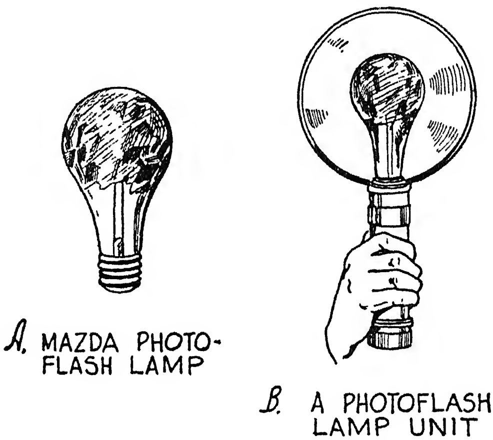


Fig. 62.—How the Photoflash Lamp Is Used

The Kalart Speed Flash or Synchronized Photoflash Unit.—There are often times when you want to make an instantaneous shot where the lighting conditions are so poor it cannot be done with even the fastest lens and film. It is obvious that however weak the light may be you cannot open the shutter, then make the flash with the hand photoflash lamp that I have described above, and close the shutter again. Wherever you have light, however dim it may be, it is necessary to release the shutter and fire the flash at the same split second of time, or *synchronously* as it is called.

Now what is termed a *speed flash* or *synchronized photoflash,* is an action picture that is taken at a high shutter speed, *i.e.,* $\frac{1}{100}$ of a second or faster, under poor lighting conditions in which the photoflash lamp is fired synchronously with the opening of the shutter, and this is what the *speed flash* or *synchronized photoflash unit* does. There are several makes of these units on the market but the one I am best acquainted with is the *Kalart,*

and this is made by the *Karlart Company, Incorporated, 58* Warren St., New York City.

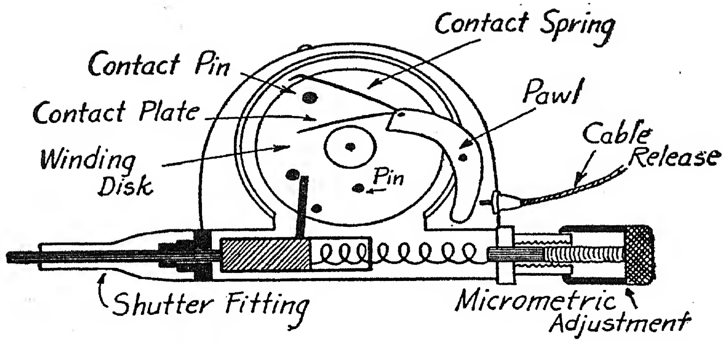
How it Is Made.—This unit consists of (*a*) a $4\frac{1}{2}$ volt battery, (*b*) a photoflash bulb, (*c*)a synchronizer, and (*d*) a cable release. The battery is enclosed in a case that is only $1\frac{1}{8} x 3 x 4\frac{1}{2}$ inches in size, and the bulb fits into a socket in it. A pair of short insulated wires leads inside of the case and one end of one of them is connected with one terminal of the socket, while the other end of the other one is connected with the other pole of the battery. The case is screwed to the top or the side of the camera.

The *synchronizer* comprises a shutter release and a contact which closes the circuit that fires the flash. The shutter release is formed of a pin which is secured to the end of a spiral spring, and this is compressed by means of a projection on the edge of the disk that is pivoted to the casing, the disk is released by a bent trigger which is also pivoted to the casing. In one end of the trigger is a notch and when this engages with a pin in the disk the latter is held in place against the tension of the spiral spring.

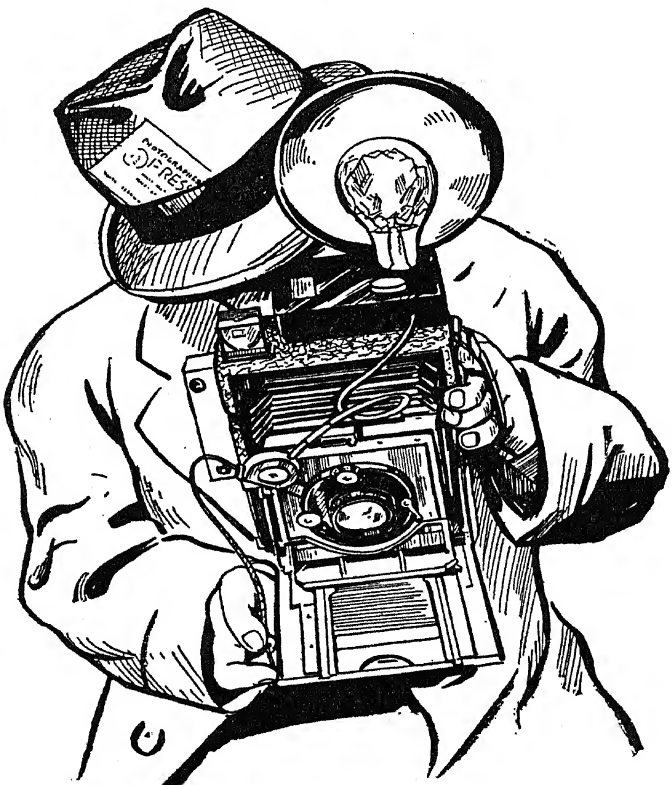
On the end of the trigger is a flat steel plate and when the disk is released it makes contact with a pin that is fixed in an insulated disk cover. One of the free ends of the battery and lamp circuit is connected with the casing, *i.e.*, it is *grounded* to it, and the other end with the pin in the insulated cover. The cable release is then fitted to the synchronizer and the coupling screwed to the nipple of the shutter; all of these various parts are shown at *A* in *Fig. 63*, except the insulated cover.

How it Works.—The way the synchronized photoflash unit works is like this: Just before you want to make the exposure you turn the milled wheel that is on the reverse side of the casing and which is fixed to the rotating disk, until the pin in the latter catches in the end of the trigger and locks it. When you are ready to make the exposure you simply press down on the cable release as per usual, and this presses on the trigger which in turn releases the shutter, and at the same instant the flat spring is brought into contact with the pin in the insulated disk cover and closes the circuit, when the current fires the flash.

The speed-flash synchronizer can be attached to cameras of



A. HOW THE SYNCHRONIZER IS MADE



B. HOW THE SYNCHRONIZER IS USED

FIG. 63.—THE KALART SPEED FLASH PHOTOFLASH UNIT

all makes, including the miniatures, except the standard-size Graflex. It is shown attached to a Speed Graphic in action at *B*. The price of it complete with battery case, battery, synchronizer, flash lamp and chrome reflector is *$13.50* and the complete outfit weighs one pound.

The Mendelsohn Graflex Speedgun.—This synchronized photo-flash light, which is made by *S. Mendelsohn, 202* East *44*th St., New York City, fits all models of the Graflex except the *National* (miniature) and a few of the older-style ones. When the *Speedgun* is installed on a *Graflex* you make the exposure exactly the same as you do for a snap-shot except that the curtain of the shutter must be set at *o* and the tension of the spring at *6*.

The Speedgun is so designed that it works in conjunction with the raising of the mirror and the closing of the shutter which normally produces an exposure of $\frac{1}{5}$ of a second; since, however, the effective duration of the flash is $1/50$ of a second the exposure is completed within that time. The price of the Speedgun complete and ready to be installed on your Graflex is *$12.50*. To get a greater coverage and longer light throw than the standard *7*-inch reflector gives, you can get an *Aplanatic* reflector at an additional cost of *$2.00*.

The Photoflood Lamp Unit.—A *photoflood lamp* is made exactly like an ordinary Mazda lamp except that the resistance of the filament is higher, and it therefore takes more current to heat it, when, it follows, it gives a brighter light. Thus an ordinary lamp takes *60, 80,* or *100* watts to heat it to brilliancy whereas the smallest photoflood lamp takes *750* watts to do so. Obviously, then, a photoflood lamp produces a far brighter light than an ordinary one and its life is proportionately shorter. Since, however, the lamp is in actual use for just the length of time you are taking the picture you can make dozens of exposures with it.

The *G-E* photoflood lamp comes in three sizes, namely *No. 1* which takes *750* watts, and costs *25* cents; *No. 2* takes *1,500* watts and, hence, it gives twice as much light as the *No. 1* lamp, and it costs *$1.00;* and, lastly, the *No. 4* lamp takes *3,000* watts, and it gives four times as much light as the *No. 1* lamp and it costs *$2.00*.

To use the photoflood lamp you must have a reflector back of it and a stand to support them as shown in *Fig. 64.* The reflectors are made of aluminum, lie flat when not in use and snap quickly into place. They can be swung in any direction and raised as high as *6* feet *4* inches or as low as *2* feet *10* inches from the floor. The tripod stand telescopes to a length of *2* feet so that it can be easily carried. The cheapest of the photoflood lamp equipments

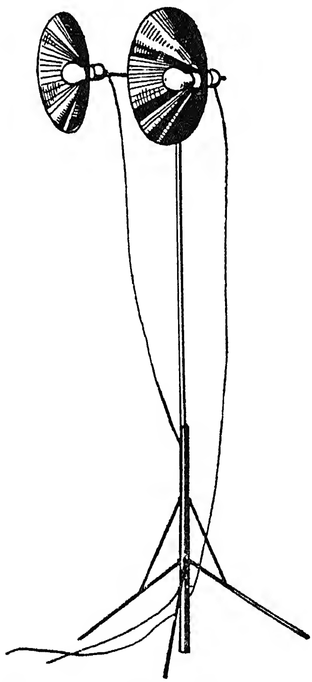


Fig. 64.—The Photoflood Lamp Telescopic Stand

is the *Kodaflector* and it is listed at *$5.00*. The various uses of photoflood lights will be explained as we push along.

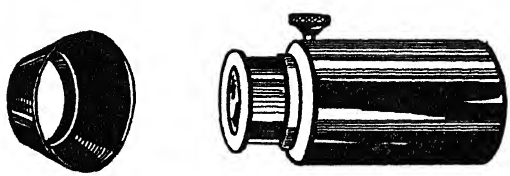
II. THE MINOR ACCESSORIES

There are several minor accessories which are often a necessity when taking pictures, and chief among these are (*1*) the hood or sunshade, (*2*) the focusing magnifier, (*3*) the camera support, and (*4*) the tripod.

The Hood or Sunshade.—Until the folding hand camera made its appearance all photographic lenses were mounted in a barrel the front end of which was provided with an enlarged extension, or *hood* as it is called. The purpose of the hood is to prevent rays of bright light, or *lens flare,* as it is termed, which were not reflected from the object, from entering the lens. These extraneous light rays that would otherwise find their way through the lens and into the camera, are distributed, more or less uniformly, over the plate or film and produce the untoward result of reducing the contrasts of the image and obscuring the details of the shadows.

With the advent of the more compact cameras and the anastigmat lenses the makers have, in nearly every case, eliminated the hood from the barrel in order to reduce its length, and thus it (the lens) has practically no protection from the extraneous rays. Now a hood or shade is a real necessity in order to take clear-cut and brilliant pictures, and there are several different kinds on the market in the form of a separate attachment.

A simple, effective and cheap one is the *Kodak adjustable lens shade*, which is pictured at *A* in *Fig. 65,* and another one is the



A. THE LENS HOOD OR SUNSHADE B. THE FOCUSING MAGNIFIER

FIG. 65.—A COUPLE OF USEFUL ACCESSORIES

De Franne. The first named is made of black, spring-sheet steel and it can be slipped over the lens barrel, supplementary lens mount, or light filter where it is held by the spring tension of it. It will fit any mount that has a diameter of not less than *1* inch and not more than *2* inches, and it can also be used on nearly any camera that has a recessed lens by means of an attachment which is provided with a projecting shoulder.

The De Franne is an imported shade[10] and it is so made that it will fit all standard lenses, and by means of an adjustable spring clip it can be used with nearly any miniature or hand camera. Inside of the shade is an extended flange which will fit any standard filter mount that has an equivalent diameter, and, hence, it serves a dual purpose.

The Focusing Magnifier.—Where you have to focus the image of a subject that is poorly lighted, as is often the case when taking interiors, or with critical sharpness in scientific work, you can use a *focusing magnifier,* provided, of course, that your camera is fitted with a ground-glass screen.

The *Rhaco* and the *Korona focusing magnifiers* are mounted in adjustable tubes; and the latter, which is shown at *B,* is fitted with a set screw to hold it in focus. The *Rhaco* has a rubber ring secured to the large end of it, and when you want to use it you press it against the area of the screen that is to be focused when it will be held there by suction. The price of the Rhaco is *$1.80,* and that of the Korona is *$3.00.*

The Camera Support.—*The Octipod and Kodapod.*—These are two useful little gadgets for supporting your hand camera when making time exposures. The *Octipod* consists of a tripod-head and a felt-lined clamp with a ball and socket joint; you can easily fasten it to a shelf, table-top, window ledge, the running board of your car or other support, and it allows your camera to be tilted to almost any angle. You can also use it to advantage with a tripod when you are taking a picture of a subject that is in such a position you cannot do so with the tripod alone. It sells for *$1.25.*

The *Kodapod* can often be used out-of-doors instead of a tripod, as the toothed jaws will firmly grip a tree, fence, or other wooden object, while the other end screws into any standard camera socket. The clamping screw allows the camera to be adjusted to the correct position and securely held there. It is easily attached and detached and is small enough to be carried in your coat pocket. The price of it is *$1.75.*

[10] The *Bass Camera Company, 179* West Madison St., Chicago, Illinois, sells it.

Kinds of Tripods.—A *tripod* is, as you probably know, a three-legged stand on which the camera is mounted to hold it perfectly still. In its simplest form it consists of a head, which is usually a small disk, and to this the legs, which are either of the folding or sliding kind, are pivoted. Now there are two chief kinds of tripods and these are (*1*) the light metal tripod, and (*2*) the heavier wooden tripod.

The *light metal tripod* has legs that are made of brass tubing and these are in sections which telescope compactly so that they can be easily carried as pictured at *A* in *Fig. 66*. There are three

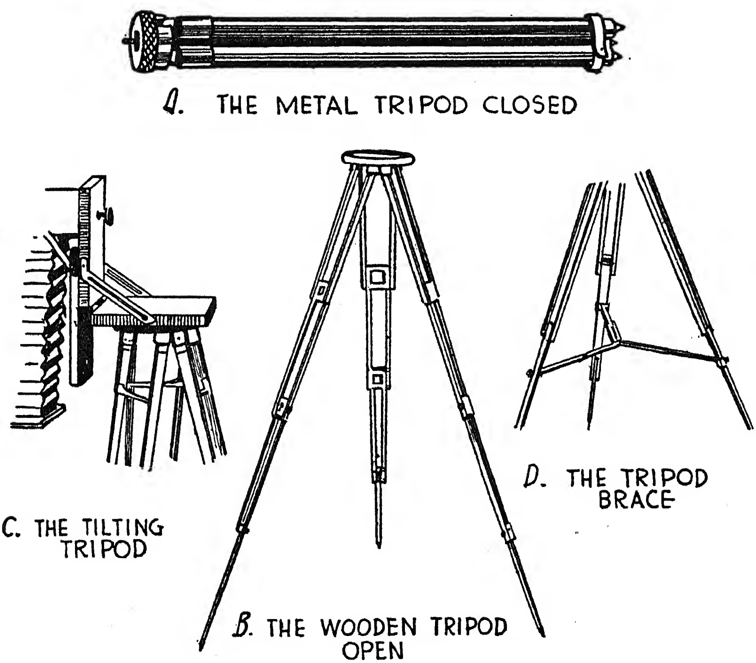


FIG. 66.—KINDS OF TRIPODS

models made of it and these have three, four, and five sections each, and measure from *13½* to *15½* inches in length when closed and *39½* to *49* inches when open. They weigh from *15* to *25* ounces, and cost from *$2.75* to *$5.00* each.

The smaller models are fitted with a revolving head and when

the camera is fastened to it, it can be swung in any direction without moving the tripod. When the tripod is used indoors the steel spurs can be covered with rubber tips. A light metal tripod should be used only with the smallest of the hand cameras.

There are several makes of *wooden tripods* on the market and these are, naturally, much stronger and more rigid than the lighter metal ones. A typical tripod of this kind is shown at *B*, and it consists of three legs each of which is made in four

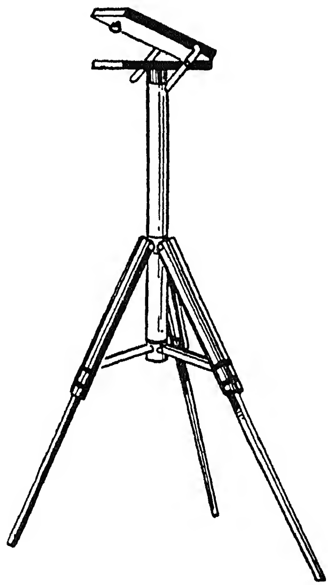


FIG. 67.—THE HOME PORTRAIT TRIPOD

sections; the three lower sections telescope into the fourth one which is firmly pivoted to the head. The length of this tripod when it is closed is *21½* inches and when open *53* inches, and it weighs *51* ounces. A substantially made tripod is a necessity where a view or other large camera is used, for there is nothing photographic that is so conducive to unsanctified language as a shaky tripod.

Very few tripods are fitted with *tilting and revolving heads*, but you can get one, see *C*, as an accessory for about *$4.00*. An-

other useful accessory is the *tripod brace* which is pictured at *D*. It consists of three adjustable brass arms one end of each of which is pivoted to the others, while the other and free ends are clamped to the tripod legs. It is used to prevent the tripod from folding up when you lift it and move it about. The list price of it is *$1.50*.

For taking architectural and general interior pictures, home portraits and other kinds of exacting work, the *Home Portrait tripod* is far better than an ordinary one. It is made of steel tubing, has a tilting aluminum top and works nicely at heights of from *2* to *5* feet. Each leg is provided with an adjustable *10*-inch extension, and the tripod itself folds up to *23½* inches. It is shown in *Fig. 67* and costs *$22.00*.

CHAPTER IX

PICTORIAL COMPOSITION

HAVING, now, a very good idea of the theoretical and practical requirements for taking pictures and assuming that you have obtained, by purchase or otherwise, a camera, you are all set to sally forth and try out your new avocation or vocation, as you will. Before you do so, however, there is one more thing you should know about and that is *pictorial composition,* for it is the keynote of making artistic, striking, and original pictures and, it follows, salable ones—that is, if you are interested in the lucrative as well as the æsthetic side of photography.

The Make-up of a Picture.—What we call a *picture* is a representation of a subject of any kind such as a person or other living thing, an object or a group of them, a landscape or a building, that is drawn, painted, photographed, or produced by any other process. Now there are three chief factors in the make-up of a really good picture and these are (*1*) depth, (*2*) tone values and (*3*) composition.

What Depth Is.—As you know, everything in Nature has *three dimensions* namely, length, breadth, and depth, while a picture has only *two dimensions,* and these are length and breadth. To make a photograph stand out as though it had three dimensions is a hard thing to do but it can be done to some extent by (*a*) using a good lens, (*b*) proper lighting and (*c*) getting the right view point.

A *good lens* is simply a matter of being able to buy one; the proper lighting of the subject, if it is a person or an object, can be more or less easily accomplished if you have artificial illumination facilities, but for landscape and architectural pictures you must depend upon your ability to judge the best time to take it to get the desired effect of high-lights, half-tones, and shadows. To get the right point of view you must know how to use the

principles of composition and these will be described as we push along.

What Tone Values Are.—The term *tone values* means the gradations of light and shade that bring out the artistic and striking qualities of a picture. They are produced, (*1*) by exercising good judgment in lighting the subject, (*2*) in selecting the proper position from which to take the picture, (*3*) using fine-grain plates or films, (*4*) the right kind of a color filter, and (*5*) correctly timing the exposure.

This latter factor is of the greatest importance in obtaining satisfying tones for by means of it you can produce high-lights and shadows that have the finest kind of gradations. If you overexpose the plate or film the high-lights will be blocked up and if you underexpose it the shadows will lack detail. Tone values depend very little on development since underdevelopment and overdevelopment merely alter them as a whole. By exercising due care in using all of the means cited above you can produce tone values in your pictures whose contrast will bring out the details in a truly marvelous manner.

What Composition Means.—The word *composition* comes from the Latin root *composito* which means that a thing is *made up of separate parts* and, it follows, when applied to a picture, the relative arrangement of the several parts which enter into it. The chief parts of a picture are (*1*) spacing, (*2*) mass, and (*3*) lines, and these must be combined not only to represent the subject but so that it will be as a whole pleasing, striking or interesting to the eye.

The word *spacing* means to *place at intervals,* and in composition it means to fill the various areas with lines that form a more or less geometrical figure, as you will presently see, the tone values of some parts of which are light and of others dark. The word *mass* means a *collective body,* and in composition it means the line-filled areas that give it tone.

The word *line* means a more or less *threadlike mark,* and in composition it means the medium by which the massing of light and shade is produced. Now there are different kinds of lines and these affect the various sense perceptions as you will presently see. In taking a picture you must arrange and compose

the lines on the ground-glass screen or finder, and this you can do by giving careful attention to the lighting of the subject and photographing it from the proper position.

The Art of Pictorial Composition.—The term *pictorial composition* means the correlated parts of a picture, be it a drawing, a painting, or a photograph which, by virtue of their vividness and intensity, are forced upon the attention of the observer. Among the best examples of current photographic pictorial composition are those published in *Life*[1] and the various other picture magazines.

The first requisite for making outstanding pictures of an artistic or a pictorial nature is, of course, a good lens and camera, but however much these may have cost, in the last analysis all they can do for you is to produce the image formed by them on the dry plate or film. The excellence of the picture you take will be determined entirely by your ability to recognize tone values and line composition. And now let's find out about the different kinds of lines and how they are used, for by the arrangement of them lies the ultimate success of the picture as a whole.

Kinds of Composition Lines.—There are a number of different kinds of lines used in composition, and these are (*a*) the horizontal, (*b*) the vertical, (*c*) the diagonal, (*d*) the curved, and (*e*) the unseen line. When combined these lines either form areas or divide the picture into parts when they are called (*1*) the dynamic or vital line, (*2*) the triangle, (*3*) the rectangle, (*4*) the cross, (*5*) radiation, (*6*) the balance, (*7*) the line of beauty, and (*8*) the circle.

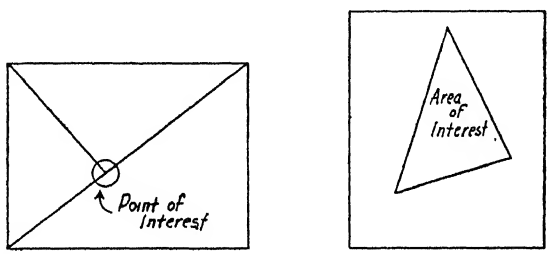
The *horizontal line* is, as you know, one that parallels the horizon. In pictorial composition it is usually to be avoided as being apt to make the picture look flat and, hence, uninteresting. Thus if you take a picture of a landscape where there is a straight road in the foreground it should not be seen as a horizontal line but, rather, it should run at an angle. There are, of course, exceptions to this rule as, for example the horizon, *i.e.*, where the earth and the sky apparently meet.

The *vertical line* is one that is at right angles to the horizontal

[1] It is published by *Time, Inc.*, 330 East 22nd Street, Chicago, Illinois.

line. The eye does not easily follow a vertical line but in the composition of landscapes where there are trees, and in architectural pictures it represents solidity, stability, and magnificence, while long vertical lines indicate loftiness and impressiveness.

Where two *diagonal lines* meet in a picture they form what is called a *dynamic* or *vital* line, and this is shown at *A* in *Fig. 68.* These lines cut the picture into three parts, the point where they meet being usually the chief one of interest. The dynamic or vital line composition is one that is frequently found in good pictures. The *triangle* is a figure formed of three lines as shown at *B,* and its effect on the visual sense perception is quite like that of the dynamic or vital line, but instead of a point of



A. THE DYNAMIC OR VITAL LINE

B. THE TRIANGLE

FIG. 68.—LINES OF COMPOSITION

interest there is an area of interest. The triangle composition is useful not only in landscape but in portrait photography as well, as it provides some very pleasing and striking effects.

The *rectangle* or *right angle* composition usually has its chief point of interest in the lower left-hand side of the picture as indicated at *A* in *Fig. 69.* There is generally a certain severity where the two lines of the angle sharply meet and this is pleasingly offset by the serenity of a pastoral scene or the like, the result of which is a striking picture. The rectangle concept is largely employed by landscape pictorial photographers.

The *cross,* which is shown at *B,* is an example of perfectly balanced composition and, it follows, the chief interest always lies in the central area of the picture. There are some subjects,

such as a single tree, or a full-rigged ship, that this kind of line composition can be used for with good pictorial effect.

The word *radiation* means a system of converging lines that meet at a given point, as at *C*, and it is largely in evidence when you are photographing plant life. Examples of it are the petals of flowers, the spreading of shrubs, and trees whose branches are reflected in a still lake or other body of water. Radiation is emblematic of youth, beauty, and vitality. In photographing sub-

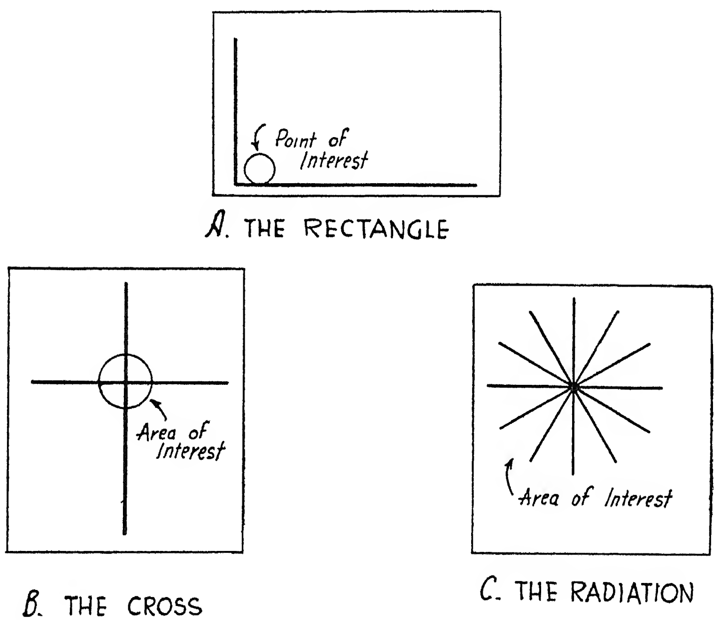


FIG. 69.—LINES OF COMPOSITION

jects of this kind you should have the area from which the radiant lines emerge above the middle of the picture.

The *scale* or *balance* in its simplest and oldest form consists of a beam that is pivoted in its middle and which has two pans of equal weight suspended from its ends. Now when a given amount of bulk matter is placed in one pan and a weight of like mass in the other pan it will, of course, exactly balance, but

where the bulk matter is lighter than the weight, the beam will, perforce, tilt at an angle, as at *A* in *Fig. 70*.

Now the idea of the scale or balance has been applied to the pictorial composition of a picture, *i.e.*, where there are two similar objects in it, and which are at some distance from each other. In taking a picture of them one should be made to appear larger than the other as, for example, two trees. The effect of balance is to strongly direct the attention of the eye to the larger one which is the chief object of interest and then to let

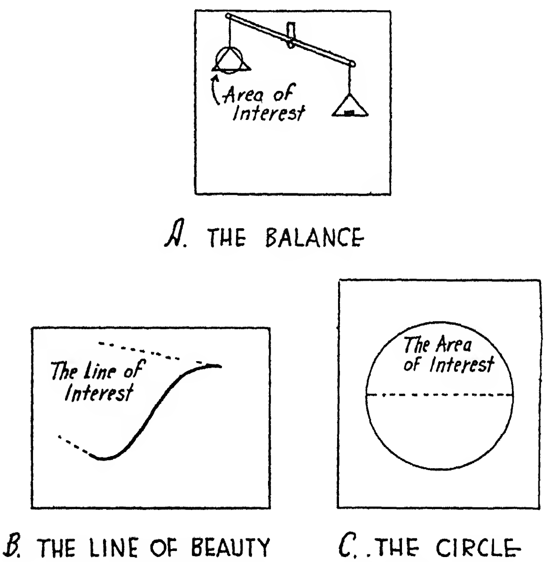


FIG. 70.—LINES OF COMPOSITION

it rest by allowing it to observe the second, the less conspicuous object, at the other and more distant point.

In the fine arts what is called *the line of beauty* is an abstract curved line that is considered to be beautiful in itself. It is variously represented by different artists but the one that is drawn like an elongated letter *S*, which was originated by Hogarth,[2] and shown at *B*, is the most generally accepted one.

[2] William Hogarth was an English painter and engraver who lived from *1697* to *1764*.

This curved line is often seen in landscapes as for example in winding roads, streams and rivers, also along ocean beaches, and in the human form. Occasionally you will find a modified form of it and this is called the *Z line*. It has a more angular form than the *S* line but it gives strength to the composition since it is a line that indicates force.

What is called the *unseen line* is an imaginary one, that is to say, one which the eye does not actually perceive as such but which it takes cognizance of and constructs for itself. Thus if you were to look at a pair of black dots separated a little on a sheet of paper your eye instinctively connects them together with a line. If there were three dots that formed a triangle your eye would immediately connect them together with bounding lines.

There are numerous arrangements of objects in nature which the eye connects together with unseen lines as for instance the tips of the petals of a flower, the tops of a row of trees, or the roofs of houses, and other things that form geometrical figures. In taking portraits, *genre*[3] pictures and landscapes, the unseen line is of considerable importance in the scheme of pictorial composition.

Lastly the *circle*, see *C*, or some segment of it, or an *ellipse*, which is a perspective view of it, often provides the chief area of interest in a picture, and its vigorous charm will attract the eye and hold it there. By bringing the above lines and figures into the picture you can get some marvelous effects that are at once artistic, forceful and striking.

The View Analyzer.—Looking at a scene from different angles to find the point of view where it will make the best pictorial study is called *analyzing* it, and when you learn to recognize the constituent parts of it and to compose them to the best advantage you will have made considerable progress in the art of pictorial composition.

Now there are three ways by which you can analyze the scene you want to take a picture of and these are (*1*) with the unaided

[3] The word *genre* (pronounced *zhon'-r*) is a style of picture that deals realistically with subjects of everyday life as distinguished from the historic, heroic, ideal or romantic treatment of them.

eye, (*2*) by viewing it on the ground-glass screen of your camera, and (*3*) to use a view analyzer. To analyze it with your unaided eye is not a very satisfactory way for you are looking at the scene in three dimensions and, it follows, you will see it quite differently from the way it will appear in two dimensions, *i.e.*, in the finished picture. To analyze the scene on the ground-glass screen of your camera you must move it from point to point, and this procedure not only takes a lot of time but it is more or less troublesome.

The easiest and most convenient way is to use a *view analyzer.*[4] This little instrument consists of a lens in one end of a barrel and this projects the image of the scene on a ground-glass screen

FIG. 71.—THE VIEW ANALYZER

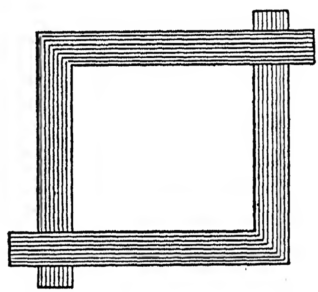


FIG. 72.—THE COMPOSITION FINDER

in the middle of it; you see the image through an eyepiece as shown in *Fig. 71*, and when you look in it you see exactly the same view that you would if you set up your camera and observed the image on the ground-glass screen of the latter although it will be, of course, very much smaller.

The Composition Finder.—This is a very simple but, withal, an exceedingly useful aid which makes it easy to find the really pictorial part of a picture after you have printed it. To make the *composition finder* you need only to cut out two L-shaped right angles of thin cardboard that are large enough to allow you to place the ends of them over each other and to cover the

[4] The view analyzer is made by *A. Adams and Company, Limited,* Charing Cross Road, London, W. C. 1, England.

print. Now by sliding these two L-shaped pieces together or apart and then looking at various parts of the picture, as shown in *Fig. 72,* you can determine the portion or portions of it that have the best elements of pictorial composition, and then trim it accordingly.

CHAPTER X

HOW TO TAKE SNAP-SHOT AND SCENIC PICTURES

As you have already observed the kind of a camera you use will largely determine the kind of pictures you want to take with it. In general the various kinds of pictures are (*1*) snap-shots, (*2*) scenic, (*3*) architectural, (*4*) interior, (*5*) portraits and groups, (*6*) miniature and candids, (*7*) action and sports, (*8*) aerial, and (*9*) night and infra-red pictures.

How to Take Snap-shots.—What are called *snap-shots* are pictures that you take of any and everything with any kind of a hand camera, *i.e.*, one that you hold in your hands and which has a shutter that will make exposures in 1/25 of a second or faster. Now the majority of people who take snap-shots are interested chiefly in getting a photographic record of scenery, homes, family and friends, interesting places, and curious things.

Since in taking snap-shots there is usually very little thought or time spent on them they will not, of a certes, possess any great artistic excellence but they will never-the-less prove mighty interesting to you and yours for a' that. Still when you make snap-shots, with even the cheapest of cameras, you want them to be as good as possible and here are a few simple hints that you should heed.

For a small hand camera, that is, one of the fixed focus or the cheaper adjustable focus kind you should use either Eastman *Verichrome*[1] or Agfa *Standard*[1] roll film as these are excellent for taking pictures under all ordinary conditions and at low shutter speeds. These films are orthochromatic and will serve every purpose except where higher speeds and full color sensitiveness are required.

Snapping the Picture.—To take a snap-shot picture with a fixed-focus camera the first thing to do is to (*1*) adjust the stop

[1] These are orthochromatic films.

so that the largest opening in it is in front of the lens. This done stand back from the subject so that that part of it which is to be the chief object of interest will be sharp in the picture and this is, ordinarily, not closer than *8* feet from the camera.

Now see to it that (*2*) the rays of the sun shine on the subject preferably at an angle of about 45 degrees as shown at *A* in *Fig. 73,* as this will give tone values, that is, light and shade effects which will produce the greatest depth. If you let the light rays fall on the subject from above and back of the camera, see *B,* the picture will then likely look flat; if they fall on the

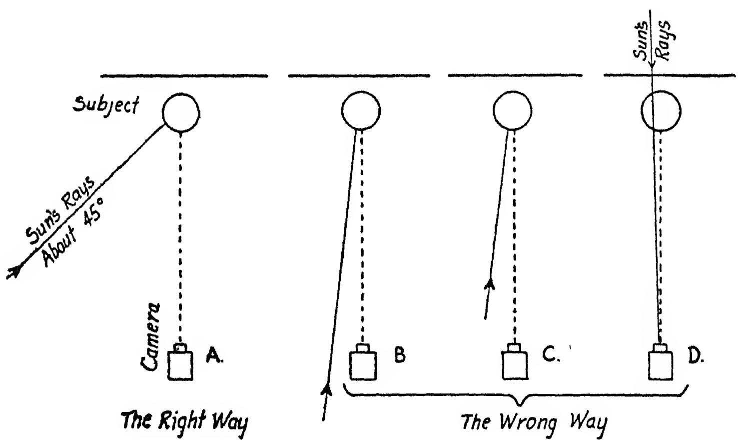


FIG. 73.—HOW TO TAKE SNAPSHOTS

subject from above and in front of the camera as at *C,* there will be a lack of detail in the picture, while if the rays strike the lens, see *D,* and pass through it they will fog the film.

Next (*3*) hold your camera up to and in front of your face if the finder on it is an eye-level one, or down and on your chest if it is a waist-level one, and be sure that it (the camera) is perfectly level. Look at the image in the finder, and (*4*) see to it that there is neither too much nor too little foreground and sky in it if it is a scenic picture, and that you see *all* of the image of the subject, that you want to have in the finished picture, especially if it is a person you are taking, for other-

wise you may find half of his head is missing or his legs cut off. Finally (*5*) press the shutter lever or the cable release when the image of the subject will be chemically impressed on the film. When (*6*) you have taken as many pictures as the film is made for take out the spool and you are ready to have them developed and prints made from them, or better, you can perform these interesting operations yourself.

About Taking Portraits.—If you want to take a bust portrait of a subject or make a larger picture of an object than you can get with the lens that your camera is fitted with you can slip a *supplementary portrait lens* over it. The best way to take a portrait with a hand camera is to have the subject sit or stand in the shade out-of-doors, use the largest stop and make an exposure of $1/25$ of a second or a little more. You can make portraits indoors by mounting your camera on a tripod, using the largest stop, having the subject sit at a distance of *3* or *4* feet from an unobscured window, and make an exposure of from *1* to *3* seconds according to the intensity of the light. Or, better, you can use a synchronized flash-light or one or more flood-lights.

How to Take Action Pictures.—Even though your camera is a cheap one you do not need to confine your pictures to *stills, i.e.,* those in which the subject or subjects are not moving. Instead, in many cases, you can take *action pictures,* or *instantaneous pictures* as they are also called. Thus with a box or other fixed-focus camera whose highest shutter speed is $1/25$ of a second you can show children at play, people walking on the street, etc.; to do this you need only to use a fast film and the largest stop; then have the subject or subjects coming directly toward you, and snap them in the bright sunlight.

If you have a camera that gives a shutter speed of $1/100$ of a second you can take all kinds of subjects in motion such as foot-, horse- and motor-car races, various games, such as tennis and baseball, and sports such as diving and pole vaulting. To take these action pictures you should stand from *20* to *30* degrees out of the line they are moving along and from *30* to *100* feet from them when you make the exposure. Naturally with a faster lens and films you can take them at a lesser angle, at a closer range, and with a shorter exposure and they will be sharper and better

in every way. Action pictures of this kind will be more fully described presently.

How to Take Scenic Pictures.—*About Scenic Photography.* —The chief difference in taking pictures with a fixed-focus camera and one that you have to focus is that with the former you must stand at a given distance from the subject to get a sharp picture of it while with the latter you can stand at any distance, within certain limits, of course, and get a sharp picture but you must focus it in order to do so. To do this you simply move the lens toward or away from the film by sliding the front board that carries it (the lens) forth and back until the image is sharp.

Now as I pointed out in the chapter dealing with the constructional details of the various cameras, this is not an easy thing to do unless (*1*) your camera has a ground-glass screen, or (*2*) you use a range finder. There are very few—too few—amateurs who use focusing cameras that employ a range finder—more's the pity. All that I have said about taking landscapes and other subjects with a box or other fixed-focus camera holds equally good when you are taking them with a folding focusing camera.

To take really good scenic pictures with the latter kind of a camera you should mount it on a tripod, stop down the lens and use a fine-grain film such as the Eastman *Fine Grain Panatomic,* the Agfa *Fine Grain Plenachrome,* or the Defender *Fine Grain Panchromatic.* These are fast films that have a wide latitude which will help you to bridge over any inaccuracies you may make in timing the exposure.

With a good lens and films of the above kind you can take pictures in the early morning, the late afternoon and on dull days. All of the films are panchromatic which renders all of the colors of the subject in their true color values, *i.e.,* exactly as the eye sees them. By using orthochromatic films and color filters you can get beautiful cloud effects and remarkable pictorial tone values in landscapes. Because of their fine grain these films produce sharp and strong enlargements of great size.

In your initial efforts to take landscapes it is better not to have human subjects in it for unless you are skilled in the art

of posing them it is not at all an easy matter to make them look as if they are a part of it. With animals it is quite different for they will always look as if they belonged there.

For a landscape to have real pictorial value it must first of all have *depth,* and a good way to give it the necessary perspective is to focus your camera on some particular object that is in the foreground and then take it from a point where the impression of space is produced by the tone values and the gradations of distinctness of the receding objects until they, at last, vanish in the distance.

Having selected the landscape you want to take and the point you want to take it from you must see that the lighting is such that it gives the greatest depth. Generally speaking this is in the early morning or the late afternoon for then the shadows soften it down. In selecting the best point from which to take a landscape is where you will find the *view analyzer* which I described in the preceding chapter, of the greatest assistance.

A new technic in taking pictorial landscapes, especially where there are figures in the foreground, and these can be in action, has been developed by the *Kalart Company,*[2] and which is called *synchro-sunlight photography.* This is based on the use of the synchronized photoflash light in conjunction with daylight. The chief features of the pictures taken in this way are (*1*) the use of *sunlight* for strong back and top lighting while the *speedflash* provides the full detail in the dark foreground and front of the subject, and (*2*) the absence of distracting detail in the background, and the way in which distant objects are silhouetted against a perfectly rendered sky.

When you are taking synchro-sunlight pictures the first thing to do is to adjust the shutter speed for the distant parts of the landscape in which the detail is to be preserved. By using a photoelectric exposure meter you will be able to get the correct shutter speed.

The flash-light should be determined by the distance of the flash bulb from the subject that is to be illuminated and this is given in the following table:

[2] The *Kalart Company, Incorporated, 58* Warren Street, New York City, will send you further information on synchro-sunlight photography.

SPEED FLASH EXPOSURE SCALE, WITH ONE FLASH BULB, FOR EXPOSURES ON VERICHROME TYPE OF FILM

DISTANCE FROM LAMP TO SUBJECT, IN FEET	LENS STOP TO USE	
	BABY SIZE NO. 10 (15 CENTS LIST) 1/100 SECOND	STANDARD NO. 20 (25 CENTS LIST) 1/200 SECOND
6	*f.11*	*f.16*
10	*f.8*	*f.11*
15	*f.6.3*	*f.8*
20	*f.4.5*	*f.6.3*
25	*f.3.5*	*f.4.5*

Note.—One stop smaller can be used for exposures on SS Panchromatic or the like extra-fast film.

A filter, such as the *K2* or ordinary sky filter, should be used to preserve the cloud detail and the filter factor must be reckoned with in determining the time of exposure.

The position of the sun can be disregarded when you use a speed flash although, of course, it must not be in a direct line with the lens. The foreground under this condition would tend to be underexposed but this is taken care of by the flash. A relatively small lens aperture is necessary to insure depth of focus, which is an important factor, as the background must be sharply defined, and the foreground is very often the subject matter of the picture. There are numerous other applications of synchro-sunlight illumination which this new technic provides and which will result in pictures equal to those produced by the Hollywood photographers.

If you will use a Wratten and Wainwright *infra-red film,* and a *No. 25 Wratten* filter[3] you can produce some very striking pictorial effects, for the sky will take on a dark hue, the shadows will be hard and the trees will look as if they were covered with

[3] You can get infra-red film and filters of *George Murphy, Incorporated,* New York City, or any first class dealer in photographic supples.

snow. The haze of the atmosphere in the distance will be greatly reduced and, it follows, the objects in the background will show up quite distinctly.

Next to taking landscapes *marine scenes* are the easiest and they generally make charming pictorial studies, especially where there are one or more boats or ships in them. In taking marine views you must look after the lighting with all due care to get the best effects, and wherever the sky forms a part of the picture you should use a *yellow color filter* to get in the clouds.

Snow scenes, especially after there has been a heavy fall, are always enchanting but it is not at all an easy matter to take them. To take a good snow picture, by which I mean one that has detail in it, you must use a *yellow filter* and the best time to make the exposure is shortly after the sun rises. Unless you use the filter it is next to impossible to differentiate the snow from the sky and to obtain the proper tone relations that are necessary to bring out the finer details of the scene.

About Timing the Exposure.—To correctly time the exposure is, as you have already observed, an all important element in taking a picture of any kind, and several factors determine what the length of time to give the best results shall be. Named these factors are (*1*) the speed of your lens, (*2*) the size of the stop you use with it, (*3*) the speed of the plate or film, and (*4*) the strength of the light rays that form the image. The latter, in turn, depends on (*a*) the time of day, (*b*) the season of the year, and (*c*) the weather conditions.

Now the first and the third above factors are fixed by the makers, the second one you control, and the fourth one is the variable that is due to Nature. As I have cited before, there are three ways by which you arrive at the time you should expose the plate or film and these are by (*1*) your inference based on past experience, which really amounts to good guessing, (*2*) the use of an exposure table and (*3*) the use of an exposure meter.

The following table gives you the approximate time of exposure for plates and films of ordinary sensitivity where you take the picture in the sunlight of summer and from, say, *9* A.M., to *3* P.M., *Standard Time*:

TABLE OF EXPOSURES

Subjects	Lens Aperture or Number of Stop				
	f.4.5	f.5.6	f.8	f.11	f.16
Clouds and sky and open sea	1/600	1/400	1/200	1/100	1/150
Landscapes, open beach, and snow scenes.	1/500	1/300	1/150	1/75	1/40
Open views, that is, with light foregrounds, open spaces and light buildings	1/300	1/200	1/100	1/50	1/25
Street scenes and other like subjects.....	1/150	1/100	1/50	1/25	1/15
Dark streets, close figures, portraits, groups in shade and subjects with heavy foregrounds	1/80	1/50	1/25	1/12	1/6
Well-lighted interiors	1/10	1/6	1/3	3/4	1 1/2
Portraits in well-lighted rooms	1/3	1/2	1	2	4

By far the better way—in fact the only sure way—to make a correctly timed exposure is to use an exposure meter, for then and then only, will you be able to time the exposure exactly right.

Taking Soft-focus Pictures.—When you take a picture with a good lens, all of the lines and details show up sharply defined, and this is usually what is wanted especially by the beginner. There is, however, another way to treat the subject and that is by giving it a soft or diffused effect in which case the lines and details are toned down so that it seems as if you were looking at the picture through your half-closed eyes. This kind is called a *soft-focus picture,* and to make it with a small camera, all you have to do is to slip a *supplementary soft-focus lens* over the lens of your camera.

To make the best possible scenic pictures you should have a *view camera* for this will enable you to see the image of the subject to the best possible advantage—albeit it will be an inverted one—and, hence, you can examine and compose it carefully in so far as this is possible by getting the proper light on it and a good point of view to take it from.

When you have the urge to take pictures with a standard view camera for the sake of art, rather than merely to get a collection of them, you will have emerged from the file of the snap-shot enthusiasts and into the ranks of the real amateur class, *i.e.*, those who are or want to become experts in the technic of photography as a means of artistic expression.

CHAPTER XI

HOW TO TAKE ARCHITECTURAL AND INTERIOR PICTURES

THE WORD *architecture* means the *art* or *science of building,* especially edifices such as houses, office buildings, hotels, churches, etc., and, it follows, architectural pictures are those made of any of the above-named kinds of structures.

Now while you can take a picture of a one- or a two-story building with a fixed-focus or a small focusing camera at fairly close range, when you take it of a high one and have to stand quite near it one of two things will happen and these are (*a*) if you hold your camera level, *i.e.,* so that the front and back of it is parallel with the front of the building the upper part of the image of it will be cut off as at *A* in *Fig. 74;* and (*b*) if you hold your camera so that the front and back of it are at an angle to the front of the building you can get all of the image of it on the film but the vertical lines will converge as at *B.*

The Use of the View Camera.—For these reasons small cameras are not at all suitable for taking pictures of architectural subjects and a *view camera* should be used instead. Now, as I have cited in *Chapter VII,* a view camera is fitted with (*a*) a rising and falling front, and (*b*) a swing back. The *rising and falling front* enables you to get in as much or as little of the foreground on the plate or film as you may care to have without the trouble of adjusting the tripod, while the *swing back* allows you to tilt the camera and still keep the back of it parallel with the front of the building as at *C.* Lastly, the *reversible* or *revolving back* allows you to take either vertical or horizontal pictures without turning the camera over and it is always mounted on a tripod.

Why a Wide-angle Lens Is Used.—Whatever the height of the building may be you can get it all on the plate or film with

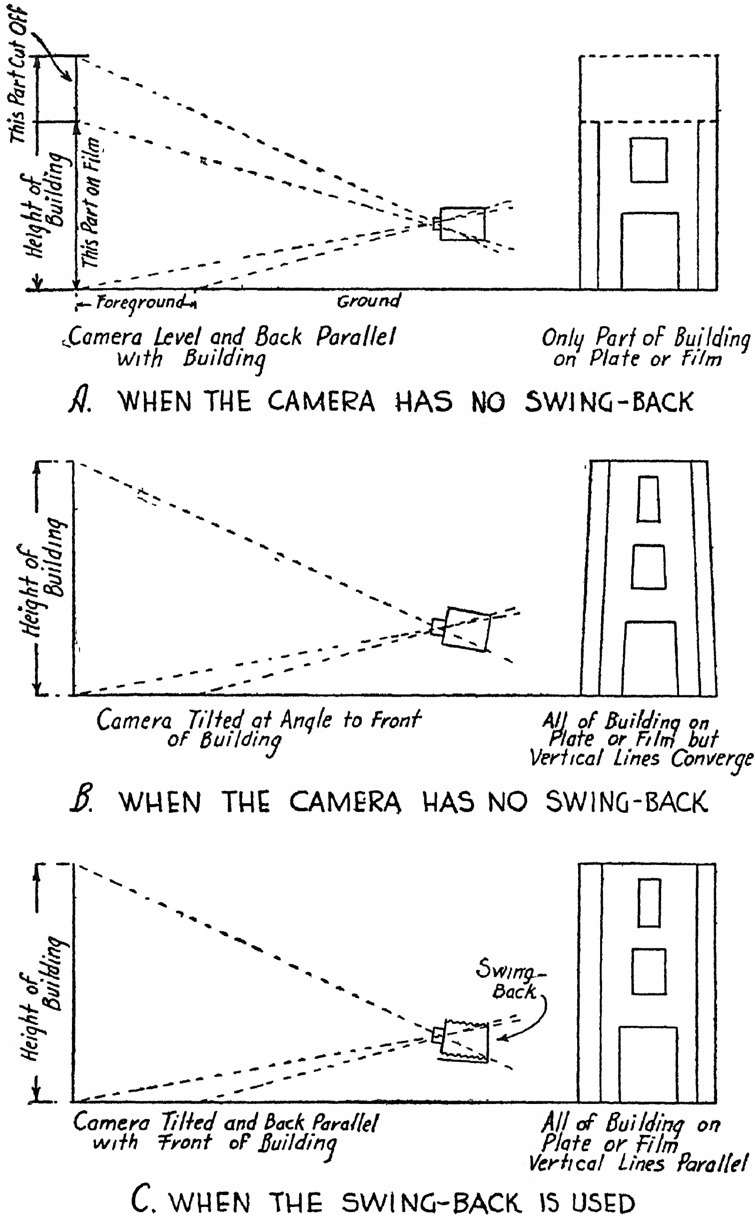


FIG. 74.—THE USE OF A CAMERA WITH AND WITHOUT A SWING BACK

any kind of a camera provided you can set it far enough away from the former. But there's the rub, for it often so happens that the point that you have to take the picture from is quite close to the building owing to the proximity of other buildings to it, or artificial or natural restrictions.

Where this is the case you can often use a wide-angle lens to advantage for it enables you to set your camera much closer to the building than when you use a long-focus lens. A glance at

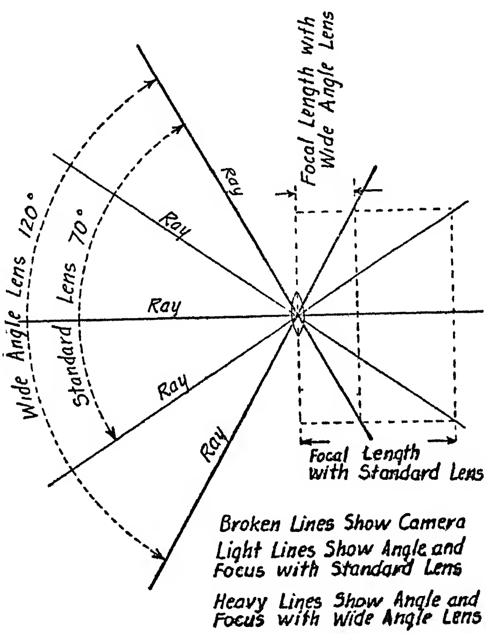


FIG. 75.—THE USE OF A WIDE-ANGLE LENS

the diagram *Fig. 75,* will show you why this is so. The standard lens is usually made to include an angle of about 70 degrees, and it has, therefore, a comparatively long focal length, while a wide-angle lens is usually made to take in an angle of 120 degrees, and some of them an angle that is greater than this and, hence, the focal length of it is proportionately shorter.

The Kind of Plates or Films to Use.—View cameras are fitted with (*a*) plate holders, and (*b*) cut-film adapters, so that you

can use either dry plates or cut films in it. In taking exteriors an orthochromatic plate or film can be used as there is, generally, but small variation in the colors of a building and, hence, this will give the color values accurately enough. For architectural pictures you should use fine-grain plates or films and these should have *anti-halation coated backs* in order to make clear, sharp prints and enlargements without loss of detail.

About Lighting the Building.—In taking a picture of a building you ordinarily want it to show the structural details as clearly and have as great a depth as possible; to do this the rays of the sun should fall on it at an angle, *i.e.*, from one side or the other, and your camera should set at an angle on the same or the opposite side of it as shown in *Fig. 76*. Should you prefer

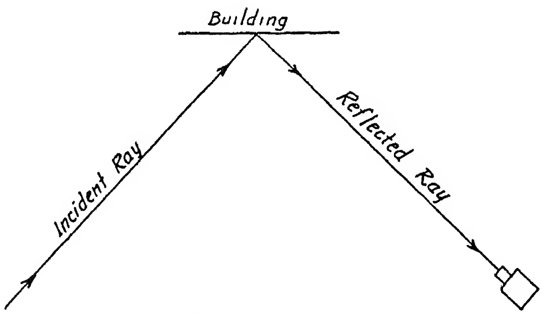


FIG. 76.—HOW TO LIGHT A BUILDING

a softer effect you can take it on a day when light clouds cut off the direct rays of the sun and they will then be diffused; or you can get about the same effect when the sun is shining by using a supplementary soft-focus lens.

Getting the Right Position.—The best position to take a picture of a building from is, of course, the one that will give the most interesting view of it. The position that you will have to take it from is something else again for there are two chief limiting factors, and these are (*1*) the angle at which the sun's rays fall on it, and (*2*) the proximity of other buildings or obstacles to it.

Where no other buildings or obstacles are in the way an angle of, say about *30* degrees from the longitudinal axis of the building is usually the best, as this shows a little more of the front of the

building than the side of it. Of course, if the side of it is wholly uninteresting a full front view is preferable. Now there are two more things that should be considered in taking the picture and these are (*a*) the height of the camera from the ground, and (*b*) the foreground that is to be included in it.

The *height of the camera* should ordinarily be about 5 feet from the ground, as this is the point that architects design their buildings, if they are to be artistic ones, to be viewed from since this is the average height of the eye of the observer. It is never good practice, albeit it is sometimes done, to have the image of the building take up all of the plate or film as this kills the depth of it, but you should set your camera far enough away from it so that there will be about the same amount of foreground in the picture that you would have if you were looking at it in order to see it to the best advantage.

How to Focus the Image.—When you have selected the point that you want to take the picture from the next step is to focus the image. To do this you open the shutter and use the full aperture of the lens, then throw a *focusing cloth,* which is usually a piece of rubberized cloth that is about a yard square, over the camera and, lastly, tuck your head under it, when you will see the inverted image of the building or other subject on the ground glass screen brightly illuminated and in its natural colors.

To get the image sharp you focus the camera by turning the milled wheel that moves either the front or the back of it along the bed. Having focused it close the shutter and if all that you want is merely a picture of it you do not need to stop down the lens, but if you want the lines and the details of it wire sharp then you must use a small stop. Should you want to make a softer and, it follows, a more artistic picture of it you can slip a *supplementary soft-focus lens* over the lens of your camera or, still better, use a soft-focus lens.

Next change the ground-glass screen for the plate or film holder, pull the slide out of it and you are ready to make the exposure. To do this consult your exposure table, or to be exactly sure use an exposure meter. When you have ascertained the time required, operate the shutter accordingly, and then slip the slide back into the holder.

Making the Exposure.—Where you have to contend with passers-by when taking a picture of a building you can either (*a*) stop down the lens and make a time exposure, or (*b*) use the largest stop and make an instantaneous exposure. With a time exposure you can close the shutter when you see that some one is going to pass in front of the camera and open it again as soon as they have gone by. If too many people are passing your only recourse is to make an instantaneous exposure.

Using the Telephoto Lens.—Not only does a telephoto lens make it possible for you to take a larger picture of a building or other subject at a distance, but it gives a far better and more pleasing perspective than you could get if you stood closer to it and used a standard lens. Further, it is of great value where you want to take certain parts and various details of a building that is too far away to show up large enough so that they can be clearly seen when you take them with a standard lens. If you have a small camera you can use a supplementary *telephoto lens* and this will give fair results but for practical work you should have a standard telephoto lens.

How to Take Interiors.—An *interior picture* is, of course, a view of a room, a hall, or some part of them. While you can take an interior picture with a camera that has a standard lens the area that you can get in it will be quite limited unless the room is a very large one, or you may, possibly, be able to take it from an adjoining room. As a rule, however, a standard lens has too long a focal length to include very much at close range.

To get in as much of the interior view as possible on the plate or film you can use (*a*) a supplementary wide-angle lens if you have a fixed-focus or folding camera, or (*b*) a regular wide-angle lens if you are using a view camera. To use a wide-angle lens your camera must have either (*a*) a movable back, or (*b*) a drop bed if it has a movable front, for otherwise it (the bed) will be in the way of the rays after you focus it, and so cut off some of them.

What to Include.—When you take a picture of a room in a home there are three chief things you must try to do, and these are to (*a*) keep the true perspective, (*b*) prevent it from looking overcrowded, and (*c*) preserve the homey atmosphere.

To *keep the true perspective* is usually a difficult job especially if the room is small and you are using a wide-angle lens, for a short focus is not at all conducive to its fulfilment. To *prevent it from looking overcrowded* with furniture have as few pieces show in the picture as possible, and these as far apart as you can consistently, and to *preserve the homey atmosphere* you must compose the pieces to the best of your ability to give it this emotional effect.

The first thing to do when you are going to take a picture of a room in a home is to look it over with all due care and see from just what vantage point you will best be able to fulfil the above-named conditions, and in doing so you will be limited very considerably by the windows that are to provide the light rays, that is, if you are going to take it by daylight.

In any event let some one object, as a chair, a table, or the fireplace, provide the chief point of interest, and have it and all of the others as far from your camera as you can. Let the smaller objects remain in their original places as long as they do not interfere with each other, *i.e.*, bunch together, for by doing so the personal element is retained.

And, finally, do not try to add life to the picture by having a person or an animal in it if you are going to take it by daylight for the only way to get a good interior picture, by which I mean one in which there is sufficient detail, is to give it a comparatively long exposure. If you want to have life studies in the picture you must take it with a photoflash or a photoflood light, and the way to do this will be described as we push along.

If you are taking a picture of a large room, such as one in a public building or in a church, be careful not to let the base of a pillar or the end of an arch be cut off as this greatly mars the composition. As a general rule it is better not to let the arch come directly in the middle of the picture but somewhat over to one side, and where a single pillar appears in the picture have it out of the center of it.

Should there be two or more pillars that you want in the picture then take them from a point where they will produce a balanced effect as described in Chapter IX, "Pictorial Composition." In taking a picture of a hall room or other long room set

your camera to one side or the other of the longitudinal middle line for then you will provide a sense of balance of the perspective.

About Lighting Interiors.—There are three ways that you can light an interior in order to take a picture of it and these are by (*1*) daylight and (*2*) controlled light.[1] To take a picture of a room that is illuminated by *daylight* which comes through the windows is usually one of the hardest things that the photographer—especially the amateur photographer—has to contend with. The positions of the windows will very often prevent you from taking it from the point you would like to and, hence, the only thing you can do is to bring all of your ingenuity into play and jockey it for place the best you can.

The best advice I can give you is to have the windows that supply the light either at the rear of, or on the sides of your camera. Where a window is in front, or on the side and far enough ahead of your camera so that it will be included in the picture it will produce *halation*, that is, the light rays that pass through it will spread around and beyond it. The chief cause of halation is the reflection of the rays that pass through the plate or film and which are reflected back and act upon the sensitized surface of it.

Now there are two ways by which you can prevent halation when you are taking interiors and these are (*a*) to cover the window with muslin, and (*b*) to use non-halation plates or films. It is often a good scheme, if the light rays are very strong, to cover the window with muslin even when you use a *non-halation plate* or *film*, as this tends to soften the tones. Your only other means of controlling daylight is to raise and lower the shades of the windows and to take the picture on a bright day when the sun is obscured by light clouds.

There are two ways that you can take pictures of interiors by using *artificial light* and these are by using (*a*) photoflash lamps and (*b*) photoflood lamps. When taking a picture of an interior where the daylight can be excluded, the photoflash lamp and the shutter of the camera need not be synchronized, but if

[1] The *General Electric Company,* Nela Park, Cleveland, Ohio, publish a booklet on *Controlled Lighting* with photo lamps, which you can get for the asking.

daylight is present it is the better practice to use a speed flash or synchronized photoflash-light.

A single *No. 20* or two *No. 10* photoflash *lamps* will provide enough light for a small interior; for one of medium size you will need two *No. 20* lamps, and for a large one from five to ten *No. 20* or two *No. 75* lamps. Where two or more photoflash lamps are used they should be fired synchronously, and this is done by connecting them in parallel to an electric battery as shown in the diagram in *Fig. 77*.

If the lamps are to be fired synchronously with the opening of the shutter the terminals must then be connected with the synchronizer of your speed flash as I explained in *Chapter VIII*. To fire one flash lamp you must use a *4½*-volt battery, and to fire *3* flash lamps you will need a *9*-volt battery. By connecting the

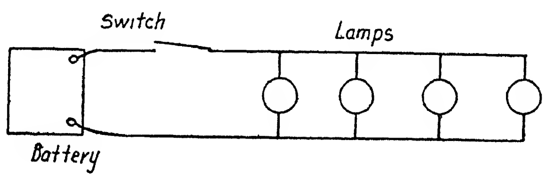
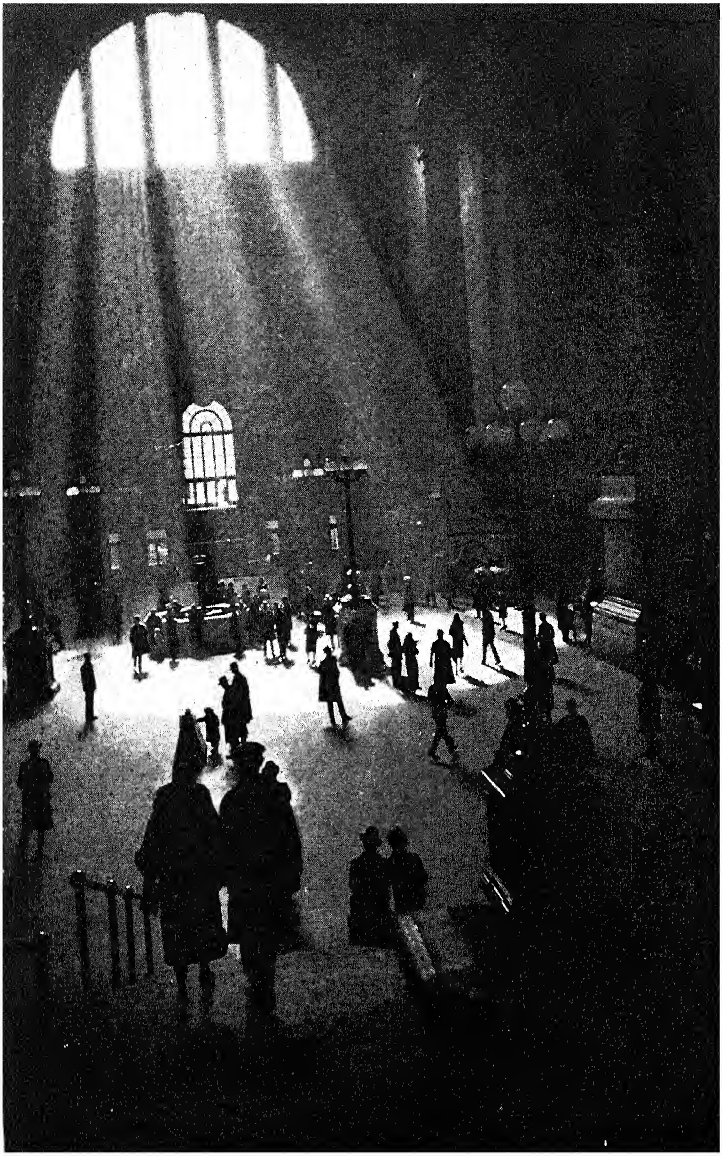


FIG. 77.—PHOTOFLASH LAMPS CONNECTED IN PARALLEL

lamps up with a flexible electric cord you can place them so that the lighting will be the most effective and also independent of the camera.

To take pictures of interiors by *photoflood lamps* is, in the final resolution, the best way for by using them you can direct the light with greater certainty and you will be the better able to see the effect of it. From *1* to *5* photoflood lamps must be used depending on (*a*) the size of the room, (*b*) the size of the photoflood lamp, (*c*) the distance of the lamps from the walls, (*d*) the opening of the lens stop, and (*e*) the time of exposure. Obviously the time of exposure can be reduced by increasing the number of the lamps, thus if two lamps require an exposure of *2* seconds then four lamps will cut down the exposure to *1* second.

How to Get a Sharp Focus.—After you have attended to the



Pennsylvania Station, New York City

(By Dr. J. L. Ruzica. f.3.5 lens; on Kodak film, 1/25 second.)

composition and lighting of the room the next thing is to get a sharp image of it on the ground-glass screen. Since the light rays are comparatively weak inside of the room it follows that the image will not be very bright and, hence, you may find it somewhat difficult to sharply focus it.

To do so to the best advantage you can either (*a*) keep your head shielded by the focusing cloth until your eyes have become accustomed to the more or less dim image, or (*b*) and this is usually the better way, to place an electric light alongside of the object that is nearest your camera and then get a sharp image of it when all other parts of the room you are including in the picture will be likewise sharp. Of course, when you are focusing you use the largest aperture of the lens, and then stop it down when you are going to make the exposure.

Now Make the Exposure.—To take an interior picture you should use a fast, fine-grain panchromatic plate or film, then stop down your lens to *f.16* and make an exposure of from *1* to *3* minutes; the exact time to give it will depend, of course, on the lighting of the room.

In making interior pictures the shadows usually appear considerably lighter on the ground-glass screen than they will in the negative. The time of exposure should be governed by the deepest shadow in the room and the only sure way to get the detail in it is to test the strength of the light at this point with an exposure meter and then time the exposure accordingly.

CHAPTER XII

HOW TO TAKE PORTRAITS AND GROUPS

While you can take portraits and groups with a small hand camera for the purpose of keeping a photographic record of your family and friends, to take *posed pictures,* especially if it is your earnest desire to financially profit thereby, you should use a camera with a ground-glass focusing screen.

The general rules for taking portraits and groups are the same whatever kind of camera you may have, but the excellence of the pictures will depend on (*1*) the camera and its lens, (*2*) the plates or films, (*3*) the lighting of the subject, (*4*) the posing of the subject, and (*5*) the timing of the exposure.

About Taking Portraits.—You can take portraits either (*1*) outdoors, or (*2*) indoors, and you can light your subject by either (*a*) daylight or (*b*) controlled light. To take *outdoor portraits* by *daylight* is easier than it is to take them indoors for the reason that you can get a more even light, and since the rays are stronger the exposure can be shorter. To take portraits outdoors by *controlled light* you must use a synchronized photoflash, when you will have a synchro-sunlight illumination. For *formal portraits,* however, by which I mean posed portraits, it is the better way to take them *indoors* and by controlled light, and in this case you use a photoflood light.

When you take portraits outdoors you can often use the shrubbery or the side of the house for a background, and indoors a portière or a wall will serve the purpose, but if you are making a vocation of portraiture then you must have a *prepared background,* which is a large square of muslin or canvas that is painted a neutral gray, and this will be described presently.

The Camera and Lens.—The view camera or the Graflex is better than any of the other portable cameras for taking portraits because it has a ground-glass focusing screen. When you take a

bust or a three-quarter portrait with most of the small hand cameras you will have to use a supplementary portrait lens in order to increase the size of the image on the plate or film, and when you do so you must stand much closer to the subject—usually about $3\frac{1}{2}$ feet; now as the shortest distance that will give a true perspective is approximately *8* feet it is easy to see that there will be some slight distortion of the image and, it follows, of the likeness of the subject.

If your camera is fitted with a standard lens you can take out the front or rear component of it and use one of them alone when the image it forms will be very much larger than the one that is formed by both components when they are used together and at the same distance from the subject. If you are going to specialize in portraiture, however, then the thing to do, of course, is to get a standard portrait lens and this should have an aperture of not less than *f.4.5*.

The Plates or Films and Filters.—The correct rendering of color values is very important in portraiture and the way to get it is to use a panchromatic film and a yellow or a green filter. When you take a picture of a subject on an ordinary plate or film without a filter it fails to bring out the fine structure of the skin and, moreover, it causes too great a contrast in the negative, with the result that the lines and defects of the face are usually exaggerated. By using the right kind of plates or films and filters you can greatly tone down the blemishes and, hence, very little retouching or dodging need be done to eliminate them.

The kinds of plates and films to use when you are taking pictures by daylight is either *Hypersensitive Panchromatic plates* or *Supersensitive Panchromatic films;* and where photoflood lights are employed you should use *Panchromatic Process* or *M plates* or *Portrait Panchromatic films*. You can use either a *series K-2 yellow filter,* or a *series X-1 light green filter*. The *K-2* filter increases the exposure about *3* times when used with an ordinary panchromatic plate or film, and about *15* times with an orthochromatic plate or film. With the above-named ultra-panchromatic plates and films the excess time is very materially reduced and so you will have no difficulty in using them for general portrait work.

How to Take Outdoor Portraits.—*About Lighting the Subject.*—When you are taking an outdoor portrait by *daylight* you must not let the direct rays of the sun fall on the subject for the high-lights and shadows will be entirely too contrasty. You must

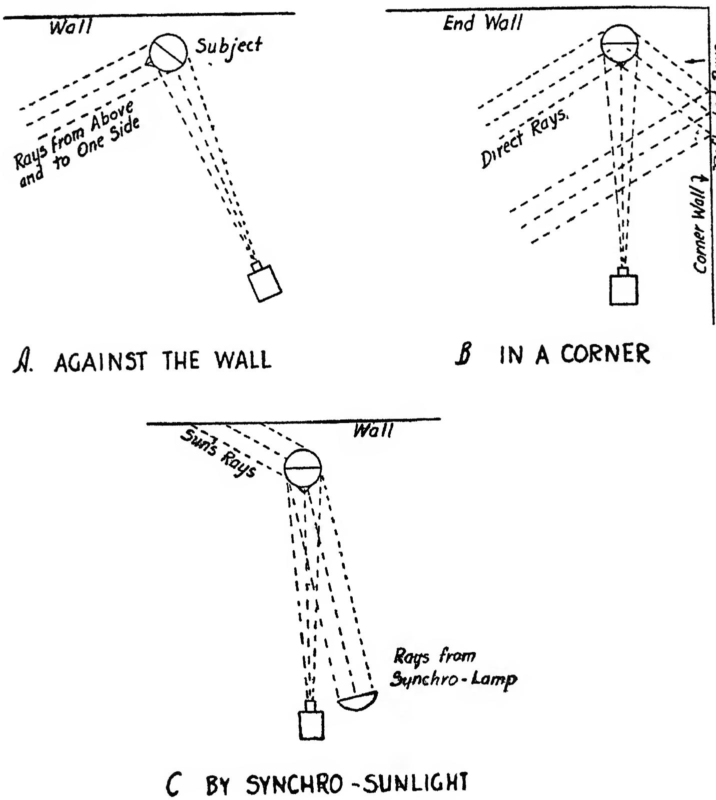


Fig. 78.—How to Take Outdoor Portraits

choose a place that is in the shade as, for example, the side of the house, a corner of it that is formed by the main wall and an ell, or on the porch or veranda of it, and all the better if these are on the north side as the light rays there will be still more diffused.

Even in these shaded places the contrast may be too great and to tone the high-lights down you can use a screen made of muslin

that is tacked to a wooden frame and suspend, or otherwise support, it; by properly placing this screen on the side of or above the subject you can get a softer lighting effect.

Now while you can take a full-length or a three-quarter length portrait and use a natural background, such as the wall of a house or one that encloses a garden, a tall flowering shrub, etc., where you are taking a bust portrait you should by all means have a prepared background. A diagram of the way to take a portrait against a wall is shown at *A* in *Fig. 78*, and in a corner at *B*.

By using a synchronized photoflash light in combination with daylight, *i.e.*, synchro-sunlight photography, you can get some very unusual and striking portraits. When you are taking outdoor portraits with a synchronized photoflash light you can direct the rays of it so that they will soften the shadows that are set up by those of the daylight and also obtain increased depth. The use of a filter, such as the *K 1* or *K 2*, will further tend to tone down the hard lines and blemishes of the face and give it a somewhat soft-focus effect. A diagram of the way to take a synchro-sunlight portrait is shown at *C*.

Focusing the Image.—To focus the image of the subject set your camera up so that the lens will be about *5* feet from the ground, as the eyes of the average person are at about this level and, it follows, it is the level at which he normally sees things. When you have the camera in position and the lighting to your satisfaction pose the subject, and then with the lens at full aperture critically examine the image on the ground-glass screen. Focus your camera on the eyes of the subject and when you can see them clearly all of the other parts of the face will be sharp.

Timing the Exposure.—After you have focused the image, stop the lens down to *f.16*, close the shutter and remove the slide from the plate holder or the film adapter; if, now, you are taking the picture by daylight only, you can give it an exposure of, say, from *1* or *2* seconds. By stopping it down to *f.22*, which is the next smaller-sized stop, you can get a still sharper picture but the exposure will have to be twice as long.

To get the exact time of exposure you must use a photoelectric exposure meter and when you test the strength of the light-rays

with it do so near that part of the subject where the light is the weakest. Timing the exposure correctly is half the battle in making a soft negative and yet full of detail and, it follows, one that will make a good print.

If you are taking the portrait by synchro-daylight you will not need to test the intensity of the light with an exposure meter. Instead all you have to do is to set the shutter to a speed of $1/25$ of a second, and then when you have posed the subject and removed the slide from the plate holder or film adapter press the cable release. From this you will see that taking a portrait outdoors by a synchronized photoflash light not only yields a better picture, but it is easier and the exposure time is greatly reduced.

How to Take Indoor Portraits.—*Lighting the Subject.*—While you can take portraits indoors by daylight the better way is to take them by photoflood light, and this is especially true if you are making a vocation of it. However, I'll tell you how to take them with both kinds of lighting and the exigencies of the circumstances will determine which one you will use.

Taking Portraits by Daylight.—To take portraits by daylight the first thing to do is to use as large a room as you can and, if possible, one whose windows face the open sky. Use only one window to provide the light, and if there are others in the room pull down the shades over them.

In taking bust and three-quarter-length portraits the subject should be sitting rather than standing because (*1*) the windows of the average room are not very high from the floor, and this tends to prevent the light from falling on top of the subject's head unless he is very close to it, and (*2*) the subject can remain still and at ease to a much better advantage.

To get the best light and shade effect you must have (*1*) a cheese-cloth diffusion screen, (*2*) a muslin reflector, and (*3*) a background. You can easily make the screen and the reflector by using a pair of light wooden frames that are about $3\frac{1}{2}$ feet on the sides, as shown at *A* in *Fig. 79,* and cover one of them with cheese-cloth and the other with bleached muslin.

Now while you can use a wall for a background, where you are going into various homes to take portraits it is much the better way to have a portable one. You can make one by painting a

large square of muslin with a neutral gray water-color, or buy a small professional one. The *Portaflex* background, see *B,* is a good one for this purpose as there is no sizing in the color and, hence, it can be rolled up on a roller and will not wrinkle or crack. You can get it in six different lightings and at a cost of from *$7.50* to *$12.00* according to size.

It is obvious that various lighting effects can be had by simply changing the relative positions of the subject, the camera, and the

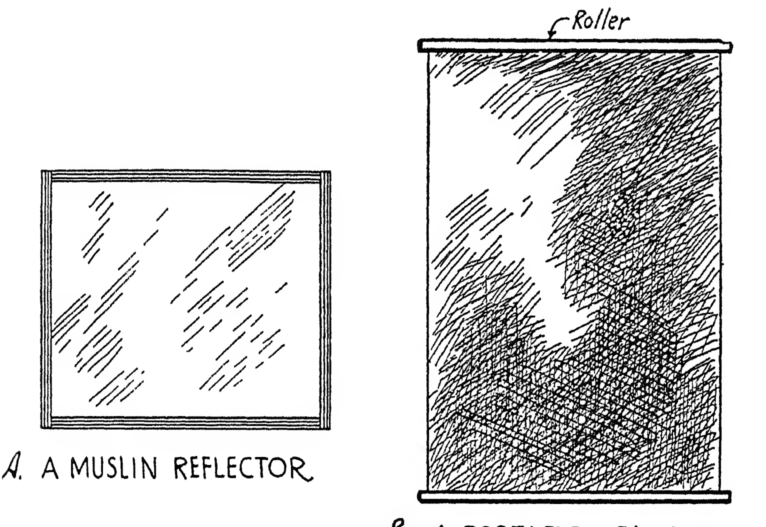


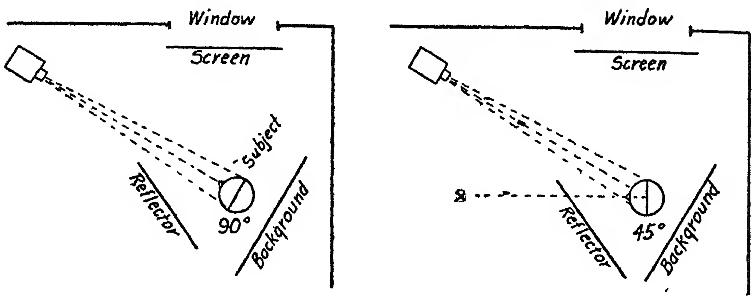
Fig. 79.—The Accessories for Taking Indoor Portraits

accessories with respect to the window. Generally speaking you must have the screen close to and in front of the window to properly diffuse the light rays while the subject should not be more than *3* or *4* feet from the latter.

The following text and accompanying diagrams will suffice to show you a few of the many lighting effects that you can get with the aid of the above accessories and you can use your own ingenuity to formulate other modifications of them.

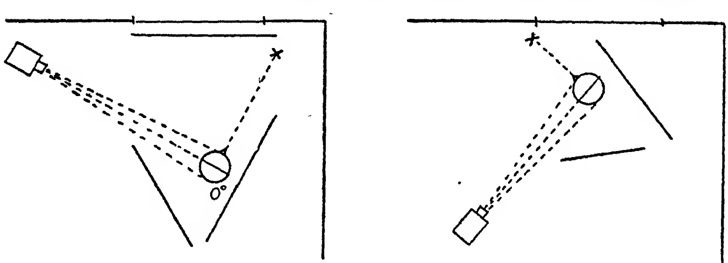
Kinds of Face Views.—There are three chief kinds of views that you can take of a subject and these are (*a*) the full-face view,

(*b*) the three-quarter face view, and (*c*) the side view, or *profile* (pronounced *pro'*-feel) as it is called. To take a *full-face view* of the subject set your camera at an angle of about *60* degrees from the line of the window, the subject back from the latter so that his full face is toward the camera, place the background



A. A FULL-FACE VIEW B. THREE-QUARTER VIEW

FIG. 80 A-B.—HOW TO TAKE PORTRAITS BY DAYLIGHT LIGHTING



C. A SIDE VIEW D. A REMBRANDT LIGHTING

FIG. 80 C-D.—HOW TO TAKE PORTRAITS BY DAYLIGHT LIGHTING

back of him at right angles to the line of the camera, the screen close to the window, and the reflector at an angle so that it will reflect the rays from the window on to the other side of his face, as shown at *A* in *Fig. 80*. Now have him look into the lens or a little to one side of it when you are ready to focus the image.

In taking a three-quarter face view have the subject, your camera, and the accessories in exactly the same relative positions as before but instead of having him directly facing the camera let

him turn his head so that it will be at an angle of *45* degrees to the line of it and look straight ahead at the *X* as shown at *B*.

In taking a side view or profile, again have the subject, your camera and the accessories in about the same relative positions as before, but in this case let him turn the side of his head toward the camera and look in the direction of the *X* as pictured at *C*.

What is called *Rembrandt*[1] *lighting* is a profile in which the side of the face is dark and the outline of the face is brightly lighted. Now to get the Rembrandt effect, which is a very striking one, seat your subject so that his full face is at an angle to the line of the window and have him look directly ahead as indicated by the broken line that terminates with the *X* as shown at *D*.

In this case do not use the diffusion screen in front of the window, and have the reflector far enough away so that while the side of his face which is toward the camera will be shaded, the lighting on it will be enough so that you can see the details of it. Finally, set the background back of him so that it is at an angle of *45* degrees to the line of the window. This done, when you focus the image you will see that the rays of light which fall on his head produce a high-light on the outline of it, and there you have a picture in the style of the great Rembrandt.

Taking Portraits by Controlled Light.—For taking home portraits indoors by controlled light you can use either (*1*) a photoflash light, or (*2*) a photoflood light. By using either of these methods of lighting the operation, as against taking them by daylight, is very greatly simplified. To take them by *photoflash light,* however, makes it more or less difficult to get the proper light and shade effect, or the desired facial expression.

Oppositely disposed the *photoflood* light makes it easy to take the very finest portraits because (*a*) the light is always uniform, (*b*) you can direct it wherever you want it and (*c*) have it of whatever intensity that may be required.

If you are going to make a business of taking portraits in homes you should have (*1*) two or, better, three separate stands with a lamp and a reflector on each one, and (*2*) a professional back-

[1] Rembrandt Van Rijn (pronounced vän *Rin'*) was a Dutch painter who lived from *1606-69*.

ground. I have previously described the photoflood lamps and stands,[2] and each of these must be connected with a sufficient length of electric cord to enable you to plug them into the sockets of convenient fixtures or in baseboards. By using the different sizes of photoflood lamps and in various arrangements you can get whatever lighting requirements you want and obtain some very unusual effects. You can use as many as *five, No. 1* or *one, No. 4* and *two, No. 1,* photoflood lamps on a single house-lighting circuit without any danger of blowing the usual *15*-ampere fuse.

The light of the photoflood lamp contains all of the colors of the sun and, hence, it harmonizes perfectly with the sensitivity of panchromatic films. Since this is the way of it you can take full advantage of the faster speed of this kind of film and at the same time secure the proper color values. A reflector should always be used with a photoflood lamp as it not only directs the light rays where they are needed, but it also increases the size of the light source and so softens the shadows and thereby improves the quality of the picture.

The Arrangement of the Lamps.—Now while you can take a portrait with a single photoflood lamp, as shown in the diagram at *A* in *Fig. 81,* you can get far better results by using two lamps —one for lighting up the subject's features and the other for softening the shadow on the other side of it, as at *B.* Where you use a pair of lamps one of them should always be in a horizontal line with the subject's face and the other one a little higher than his head.

A still better arrangement is to use three lamps and one of these should be directly above the subject's head as pictured at *C.* Finally you can get a beautiful Rembrandt lighting effect by using four lamps placed as shown at *D.* You can get a booklet that gives several half-tone reproductions of actual photographs together with accompanying diagrams that show how they were lighted with photoflood lamps for the asking by writing to the *General Electric Company,* Nela Park, Cleveland, Ohio.

How to Pose the Subject.—While I have told you above how to place the subject, your camera, and the accessories for lighting various kinds of face views there is another and vital factor

[2] See Chapter VIII.

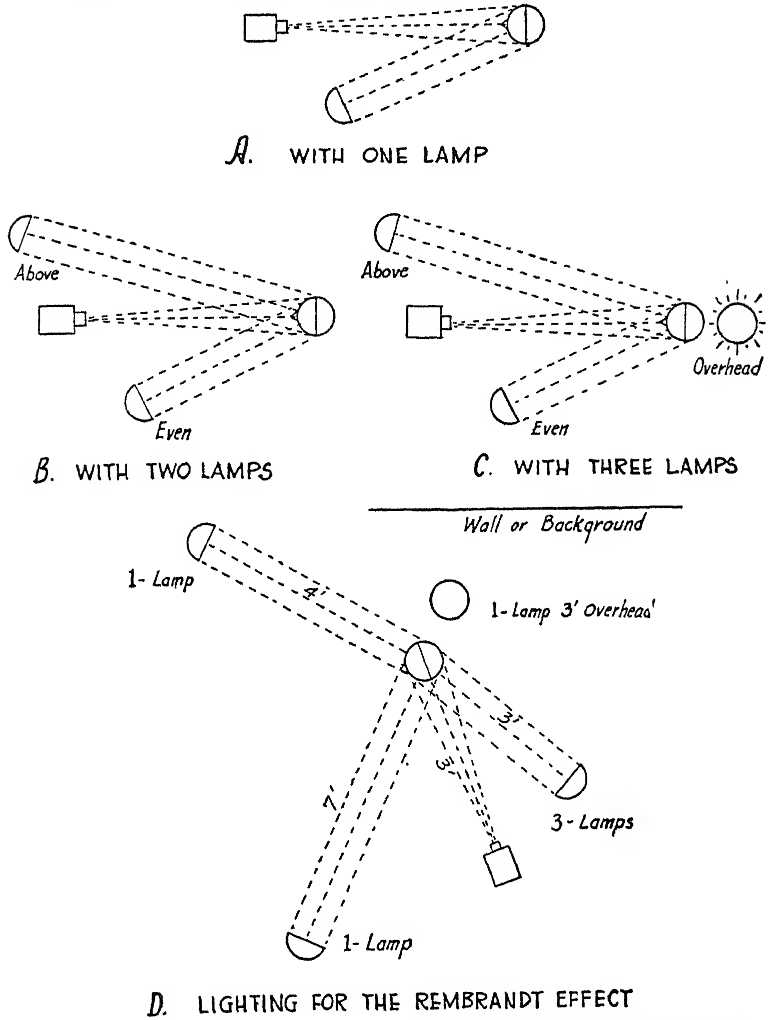


FIG. 81.—HOW TO TAKE INDOOR PORTRAITS BY FLOODLAMP LIGHTING

in taking portraits and that is the pose of the subject. Now in portraiture the word *pose* means that you place the subject in such a position, have his face at such an angle and his features assume such an expression that his charm, or personality, or both, will be brought out in the image and, it follows, in the finished

picture. It is your concern, then, as a photographer, to bring out these characteristics and the better you are able to do so the finer your portraits will be.

Now subjects for portraits can be divided into five classes, and named these are (*1*) babies, (*2*) children, (*3*) older girls and boys, (*4*) women and men, and (*5*) the old folks.

If you take up portraiture for the mere love of it you will have all of the above classes as your subjects, but if you are going to specialize in it as a money-making proposition then my advice to you is confine your work to children that are between the ages of, say, three and twelve years. The two chief reasons why, in my opinion, you should do so is because it is (*a*) easier to take pictures of them, and (*b*) to get orders for them.

Should you be called upon to take a picture of a *baby* this is the one case where you won't have to do any posing for it will do so by its own little self, and all that you have to do is to catch it at the instant you think it is the cutest. Now there are two ways to take a baby picture and these are (*a*) all by its only, and (*b*) with its mamma. In the latter instance you can have the mother holding it or sitting beside it. When you are taking a baby picture it is not a good scheme to have any toys or animals in the composition as these usually detract from the interest of it.

Children who are old enough to listen to what you have to say and will pose and assume the expression you ask them to are not only the most easily photographed but the negatives and prints do not need to be retouched since they have no lines or other facial blemishes in them. When taking a picture of a child it should be dressed in clothes of simple design and light colors, and the color scheme should harmonize all through the study.

Girls up to *sweet-sixteen* usually make excellent subjects for they are always pretty, and with their natural charm and exuberant vitality they are easy to look at, to pose, and to take. Since the features of girls are symmetrical, a full-face view, or one that is almost so, is often the most pleasing. While a serious and interested expression generally gives a better likeness, a livelier and happier picture can often be obtained by having them smile.

Boys are not as easy to photograph as girls of the same age for they are more self-conscious and tend to be wanting in ease and grace. As a rule they are not as tractable, but with a little tact you can win them over and so take good pictures of them. If possible have them wear clothes in light shades, preferably gray. It is seldom that a smile helps along either a boy's good looks or the likeness of him unless he should be of an especially winsome Hollywood type.

To take a picture of a *young woman* that will look like her, and which she will like, is easy plus for she will have reached the age of pulchritude, and that come-hither expression which she can assume is not only becoming but often positively bewitching. Not so, however, with the one who has arrived at middle age, or thereabouts, for her rôle of youthfulness in the drama of life is past and however good the likeness of her may be she will probably see it with an astigmatic eye. The best you can do, therefore, is to strive to light and compose the subject's features so that the picture of her will be as graceful and attractive as possible.

Young men are about as easy to take pictures of as young women, and middle-aged men are not nearly as fussy as middle-aged women. To please a man of whatever age you must take him in one of his serious moods which shows his character. Yes, character is the keynote in photographing a man—to take him as he would have others see him. You know, the intellectual brow, the keen and penetrating eyes, the firm but kindly mouth and the strong "get the message to Garcia" chin, *et cetera.*

Now nearly every man has studied his own facial expression in the mirror, and many have trained their features to take on the expression that gives him the character he wants to be known by. So the best thing to do is to let him pose himself and by allowing him to do so, he will, in any event, be more than likely satisfied with the picture you have taken of him.

Curiously enough the *old folks* at home make the best subjects for pictorial studies and, further, they are the easiest to take. As a commercial proposition they are practically off the record for mighty few of them want to have their pictures taken, especially if they have to pay for them. Getting back to the artistic

side of taking their pictures their characters are indelibly expressed by their features and since these can be changed but very little by composition it follows that not much posing will be necessary.

Your chief concern then is to get the right view of the subject's face and the proper lighting of it and neither of these is at all hard to do. While head studies of old people make the wrinkles and blemishes show up unduly it is these very defects that often give the subject an individual pictorial effect. Three-quarter studies are sometimes better than bust studies for they may portray the distinctive qualities of the subject to a better advantage, but these are things that you must determine for yourself. In three-quarter and full-length studies it is always the better practice to have the subject seated and, finally, the lighting should be full and bright but it should be evenly diffused.

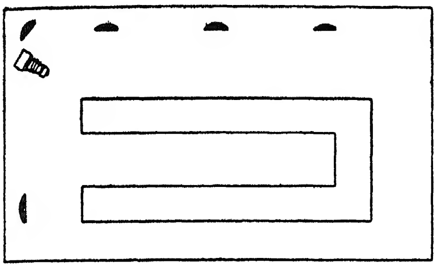
How to Take Groups.—In photography the word *group* means that two or more figures are included in the picture. Now there are two kinds of group pictures and these are (*1*) small group pictures, and (*2*) large or mass group pictures. You can take small group and large group pictures either (*a*) outdoors, or (*b*) indoors. If you are going to take a group outdoors the best way to do so is by using daylight, and if you are going to take it indoors the thing to do is to use flash-lights.

A small group may include from two to six or even eight figures, while a large, or mass group may have any number of figures in it. There are two kinds of small group studies, and these are (*a*) conventional, and (*b*) genre, or story-telling studies. *Conventional studies* are posed in exactly the same way that portrait studies are, while *genre*, or *story-telling studies* are composed to show a little group that is interested in doing some particular thing.

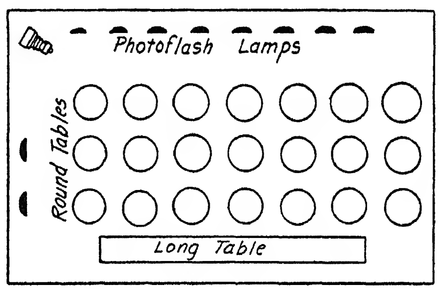
Thus a small family group may be conventionally posed by placing them in a standing or a sitting position, or both, and looking after all of the details of composition and lighting just as though you were taking a portrait of a single subject. You can sometimes lend an added interest to the picture by having the members of the group doing something in common, such as looking at a vase of flowers, or if outdoors at a flowering shrub.

In taking large or mass groups you have little choice in the matter of either composition or of lighting, and about the best you can do is to get in all of the figures so that the face of each one can be clearly seen and so that the lighting of all of them is equal in tone and strength.

In taking outdoor groups select a place where the light is dif-



A. ARRANGEMENT FOR TAKING A MEDIUM-SIZE GROUP



B. ARRANGEMENT FOR TAKING A LARGE GROUP

FIG. 82.—HOW TO TAKE GROUPS BY SYNCHRONIZED FLASHLIGHT LIGHTING

fused, the background a pleasing one, and do not crowd the figures too closely together. To get the variation needed to relieve the monotony you can have some of them standing and others seated. Where you are taking a large group an artistic effect need not be attempted for after all it is simply a photographic record whose sole interest lies in the coming together of the body of individuals who are in it.

To take an indoor group the synchronized photoflash light

must be used. For small groups *2* or more *No. 1* lamps with *7*-inch reflectors will suffice, but for large groups from *5* to *10* *No. 4* lamps with *20*-inch reflectors must be used. Whatever the size of the group place your camera in one corner of the room, and one or two lamps at the end of it that is nearest your camera, and from four to eight lamps along one side of it.

Use a normal panchromatic film and stop your lens down to *f.16*. The diagram at *A* in *Fig. 82* shows the arrangement of the camera and lamps for taking a group where upwards of *60* individuals are seated around the U-shaped table, and the one at *B* where over *150* persons formed it.

CHAPTER XIII

HOW TO TAKE NIGHT PICTURES

In the chapters that have gone before I have told you how to take pictures by daylight and also by controlled light. There is, however, another kind of photographic technic that has to do with taking pictures at night, and this is not only highly interesting as a hobby but its end-product has a distinctly marketable value. The category includes such unusual pictures as (*1*) moonlight scenes, (*2*) floodlight pictures of buildings, and street scenes, (*3*) fires, (*4*) fireworks, (*5*) lightning and, as a spectacular climax, (*6*) pictures taken in total darkness with infra-red rays.

How to Take Moonlight Scenes.—There are two ways that you can take *moonlight scenes* and these are (*a*) by actual moonlight, and (*b*)—believe it or not, Mr. Ripley—by sunlight. Since the moon shines by the reflected rays of the sun the mode of taking pictures by its light is exactly the same as that of taking them by the light of the latter, and the only difference is one of degree since the time of exposure must be enormously increased.

To find the time required for making an exposure by moonlight you can use this rule-o'thumb method: say the exposure you would have to give the scene by daylight would be $1/100$ of a second, then you would have to give it *25* minutes by moonlight—that is, when the moon is full. When it is only half-full the rays from it are less than half as strong and so you would have to give it an exposure of *60* or *70* minutes.

Again if you take a picture by moonlight with a box or other camera that has a lens with an *f.16* aperture the exposure would have to be *100* minutes long. Naturally this time could be cut down by half if you use an *f.8* lens, and proportionately less by using a faster lens. Should you want the picture to be as bright as it would be if you took it in the daytime you will have to multiply the above exposures by *4*.

As a matter of precise statement there is really nothing to be gained by taking a scene by moonlight for you can get precisely the same effects by taking them by sunlight, provided you do so at the right time. This is when the sun is setting and the western sky is banked with clouds. The sun must be wholly hidden by them and you can take the picture with an *f.16* lens by giving it an exposure of $\frac{1}{25}$ of a second. To further give the finished picture the moonlight effect you must print it long enough so that all of the parts of it will be dark except the high-lights.

How to Take Floodlight Pictures.—By *floodlight pictures* are meant those that are taken of buildings whose exteriors are brilliantly but uniformly illuminated by powerful floodlights which are projected upon it from various vantage points. In every large city you will find outstanding commercial and other public buildings lighted in this way as, for example, the Capitol at Washington.

In taking pictures of floodlighted buildings you should use super-sensitive (*SS*) panchromatic plates or films and have your camera mounted on a tripod. Keep all of the street lights out of the foreground as nearly as you can. The time required for the exposure will be from *2* to *3* minutes with a box or other camera that is fitted with an *f.16* lens or if the time element is of no consequence you can use a slower film and give it from *4* to *6* minutes.

How to Take Buildings and Street Scenes After Dark.—To take pictures of homes, store fronts, buildings, and street scenes after dark is a most alluring photographic hobby and the results of it are so striking you should not miss the fun and thrill of it. The brightly lighted windows of buildings together with the exterior illumination of them is always sufficient to show their outlines. The most striking and familiar pictures of bloc buildings at night are those taken of Manhattan from the opposite side of either the North or the East Rivers.

Then, too, the main street of every large city with its powerful incandescent lamp and neon tube lighting makes it an easy matter to take pictures of it at night. The best-known example is the *Great White Way* in New York. Street scenes of whatever

kind taken on a rainy night when the pavements are wet and reflect the lights are always interesting in their pictorial aspects.

If pedestrians are passing between your camera and the building or street scene you are taking they will not show as long as they keep on moving but if they should stop you must cover the lens with your hand, hat, or shutter until they are out of the field. And you must do the same thing when a street-car or a motor-car passes by for otherwise the lights they carry will show as white streaks in the picture.

You can take night pictures with a camera having an *f.16* lens by using a super-sensitive panchromatic film and giving it an exposure of from *3* to *5* minutes; with an *f.11* lens you can cut down the time of exposure to *1* second, and with an *f.4.5* or, better, and *f.3.5* lens you can take a snap-shot of it.

How to Take a Fire at Night.—A building on fire with its eddying flames, smoke pouring out of the windows and blazing from the roof is about the most impressive spectacle that is given the city man to see, and when it happens at night it is a hundred fold more so. A fire, that is, a big fire, does not happen very often and so to get a picture of one you must be alert and all ready to run for it when the alarm is turned in.

When you arrive at the scene of action pick out the best vantage point you can find—and be sure it is a safe one too—and take one or more pictures of it. This done have your camera all ready to take another picture of it for something spectacular may happen at any moment such as a wall crashing to the street below, or the collapse of the building itself.

The best kind of a lens to take pictures of fires with is one that has an *f.4.5*, or an *f.3.5* lens for then you can take snap-shots of it. If you have a slower lens than this you will have to mount your camera on a tripod and make a time exposure. With an *f.8* lens an exposure of *2* to *3* seconds will suffice; with an *f.11* lens from *3* to *5* seconds, and with an *f.16* from *5* to *10* seconds or more. Whatever kind of a lens your camera is fitted with use a panchromatic film, as the flames are chiefly red and orange and this will give them their true color values. The film should also be a super-speed one or the exposures will have to be very much longer than those cited above.

How to Take Fireworks and Lightning.—Both fireworks and lightning make novel and spectacular pictures, and you can take either of them without any particular trouble. In taking pictures of *fireworks* you need only to go to the place where the display is to come off, select the best vantage point you can find and set up your camera.

Now there are two kinds of fireworks displays and these are (*1*) set pieces and (*2*) aerial pieces. *Set pieces* are those that are secured to a framework and, it follows, are fired off near the ground, while *aerial pieces* are those which are shot high into the air and burst there. In taking set pieces there must not be any obstructions between them and your camera, while in taking aerial pieces the sky must be perfectly dark back of them. You must mount your camera on a tripod and give it an exposure of about *1* second.

In taking pictures of *lightning* you should focus your camera at its greatest distance, *i.e.,* infinity, which is usually *100* feet if it is a small focusing one. This done hold or set it up in an open window, and then point it in the direction where the previous flashes have taken place. Now there are two kinds of lightning flashes, namely those that strike (*1*) between two clouds, and (*2*) between a cloud and the earth.

Either kind is sufficiently intense and vivid to make spectacular pictures but the blinding, zig-zag bolts of the latter are by all odds the most fascinating. In taking pictures of lightning you can hold your camera in your hand if you want a single flash to show on the plate or film; if you try to take two or more successive flashes you will have an equal number of horizon lines because you can't hold your camera still. By mounting your camera on a tripod and then letting the shutter remain open you can take as many successive flashes as you may care to and there will only be one horizon line.

How to Take Pictures in the Dark.—To take a picture in the dark, *i.e.,* without light waves, sounds very like a paradox but when you know how it is done the seeming contradiction vanishes into thin air. As you know, the human eye can sense a range of light waves that vary in length from *short* ones that

produce the sensation of violet, to *long* ones that produce the sensation of *red.*

Now there are waves that are just a little shorter than those that produce the sensation of violet and which do not affect the eye, and these are called *ultra-violet waves,* and at the other end of the spectrum are waves that are a little longer than those that produce the sensation of red and which the eye likewise cannot sense, and these are called *infra-red waves.*

It must be clear, then, that if you set up rays of either ultra-violet waves or infra-red waves in a room where none of the other intermediate waves which produce the sensation of the various colors are present it will be perfectly dark. Now ultra-violet waves act very energetically on any kind of a sensitized plate or film, but however they are set up the slightly longer visible violet waves are produced and as these cannot be entirely screened out they light up the room.

Oppositely, infra-red waves act very little, if at all, on a non-color or on an orthochromatic plate or film, but they will do so slightly on a panchromatic one, and quite strongly on one that has been sensitized especially for them (the infra-red waves).

There are several ways by which you can set up infra-red waves so that the red waves, which are visible and would, therefore, light up the room, can be suppressed. The best way to set up infra-red waves is to use one or more *500*- or *1,000*-watt incandescent lamps and enclose them in a light-tight box or booth, the open top of which is covered with very deep filters, so that only the infra-red waves which are set up by the lamps will pass through them.

If, now, you will use an infra-red plate or film, then focus your camera on the subject, turn out all of the lights in the room so that it will be perfectly dark, then turn on those in the box or booth that set up the infra-red waves and make an exposure of *3* or more seconds, the time of which depends on the speed of your lens and the intensity of the infra-red waves, you can take a very striking picture of a subject or a group in total darkness.

CHAPTER XIV

HOW TO TAKE PICTURES WITH A MINIATURE CAMERA

THE *miniature camera,* or *minicam,* or *vest pocket,* or just *V. P.*, as it is often called for short, is the nearest approach to a universal camera that has yet been produced, and because of its versatility, compactness and ability to take a large number of pictures without reloading it is the camera *par excellence* for the serious-minded amateur.

The miniature camera was invented in *1914* by Oskar Barnack, a clever young mechanician, of the E. Leitz Works at Wetzler, Germany, and it was introduced into the United States about *10* years later, and since that time it has grown mightily in popularity every year until it is now the prime favorite of camera enthusiasts everywhere.

The Equipment You Need.—To take miniature pictures you will need the following equipment, to wit, (*1*) a miniature camera, (*2*) a standard lens, (*3*) a wide-angle lens, (*4*) a portrait lens, (*5*) a telephoto lens, (*6*) a yellow or green filter of medium density, (*7*) a range finder, (*8*) an exposure meter, (*9*) a carrying case, and (*10*) a supply of roll film.

The miniature camera can be any one of those that I described in Chapter VII, "The Camera and All About It." The two best-known miniatures are, however, the Leitz *Leica* and the Zeiss *Contax,* and there is considerable rivalry among those who own them as to their relative merits. My personal opinion is that whichever one you get you will come to swear by it and will have no other.

Whatever make of miniature camera you buy it will be fitted with a *50mm.* focus lens and this will serve your purpose admirably if you want to take the usual run of pictures. A wide-angle, portrait, and a telephoto lens are needed only if it is your desire to be able to take pictures in which these specialized

lenses must be used. If you are going to take pictures under ordinary conditions an anastigmat lens that has an aperture of *f.4.5* will be fast enough, but if you want to take them under adverse lighting conditions, such as in poorly illuminated interiors and at night, you should have a Leitz *f.2 Summar,* or a Zeiss *f.1.4 Sonnar.*

A wide-angle lens is not only useful for taking interiors but it is the kind of a lens you should use with which to take large groups. It is not quite as fast as a standard lens, and you will not be able to make snap-shots with it unless the lighting conditions are quite good. The *telephoto lens* is the one you want to use for taking *close-ups* or *candids* at a distance and I'll tell you more about these a little further along.

Man, Know Thy Minicam.—I do not know whether it was Plato or Bruno Lessing who gave us the choice bit of wisdom that is summed up in the brief axiom, "Make it thy business to know thyself," but I'm telling you that if you have a minicam, or any other kind of a camera for that matter, you *must know it* if you are to take anything like good pictures with it.

A camera of any kind is a scientific instrument and the miniature camera is one that has all of the refinements that are known to camera engineers at the present time, and these are compressed into the smallest possible space. So don't think for a minute that you can go into a store and buy one of these cameras, and then without knowing anything about its operation you can take good or even indifferent pictures with it.

So the first thing to do is to let the salesman show you how to operate each part of it separately and then as a unit. The different operations are (*a*) loading it with the film, (*b*) adjusting the focus of the lens, (*c*) stopping down the lens, (*d*) operating the shutter, (*e*) framing the image in the finder, (*f*) finding the distance with the range finder and, lastly, (*g*) determining the intensity of the light rays with the exposure meter.

Then when you get your camera home try out all of these devices and be sure that you know just how they work and how to work them before you begin to take pictures, and then you can hie yourself hither and be reasonably sure of getting the kind

of pictures you have a right to expect of your miniature, but high-priced camera.

The Kinds of Films to Use.—In the larger miniature cameras such as the National *Graflex,* Series II, regular roll films that have *8* exposures to the spool are used, but for true miniature cameras, such as the *Argus,* the *Leica,* and the *Contax,* standard perforated *35mm.* moving-picture film that has *36* exposures per loading is used.

The two chief requirements that a film which is to be used in a miniature camera must have are (*a*) high speed and (*b*) fine grain, and any of the following brands will be found to possess these qualities. The best known miniature camera films on this side of the Atlantic are (*1*) the Eastman *Super X Pan, Super Sensitive Pan, Fine Grain Panatomic* and *Infra-Red;* (*2*) the Du Pont *Superior Pan, Fine Grain Parapan, Micropan* and *Infra D,* and (*3*) the Agfa *Plenachrome Ortho, Super Pan, Finopan, Reversible Pan,* and *Infra-Red,* while (*4*) the Gevaert *Panchromosa,* (*5*) the Pero *Peromnia* and other foreign makes can be bought in the open market. While all of the above are *35mm., 36* exposure *daylight loading magazines,* you can also get them on *daylight loading spools* with paper leader and trailer that are made especially for the Contax and similar Zeiss Ikon cameras without additional cost.

Roll Versus Bulk Film.—By buying the above films in bulk, *i.e.,* in *25, 50,* or *100* foot lengths, then cutting them into shorter lengths, winding them yourself and loading them in your darkroom you can save about *50* per cent of the cost of the above spool films.

To aid you in winding bulk film you should have a film winder[1] and you can get either (*1*) a hand film winder, or (*2*) a crank film winder. The *hand film* winder which is shown at *A* in *Fig. 83,* costs *45* cents, while the crank film winder, see *B,* is listed at *$6.00.* When winding the film on the spool do not put it on too tightly as this is very apt to cause it to scratch the negatives.

Miniature Color Films.—The two chief films for taking three-color pictures are (*1*) the Kodachrome, and (*2*) the Dufaycolor. The *Kodachrome* film has *18* exposures and can be had in either

[1] *E. Leitz, Incorporated, 730* Fifth Ave., New York City, sells them.

daylight loading magazines or in rolls for loading in artificial light, while the *Dufaycolor* film has *12* and *36* exposures in daylight loading magazines and *30* exposures for daylight spools, for the Zeiss Contax.

About Hypersensitive Films.—Should you want to take a picture where the lighting conditions are so poor that the fastest film is too slow, you can try the expedient of using a *hypersensitive film* and you will find this is from *50* to *100* per cent faster than those I have described above. Now a hypersensitized film is one

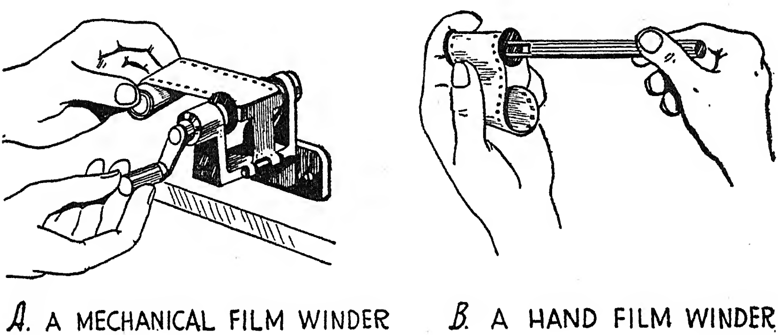


FIG. 83.—KINDS OF FILM WINDERS

whose sensitivity has been increased by either (*1*) treating it with ammonia, or (*2*) prefogging it.

The DuPont and, presumably other companies, will supply you with any length of film freshly treated with *ammonia,* but you will have to get it of them direct and then use it as soon as it reaches you for it loses its hypersensitivity in a few days. You can, however, hypersensitize your own films by immersing any of the above-named ones in a *2* per cent solution of concentrated liquid ammonia.

To hypersensitize a film by *prefogging* it you must expose it to the action of very feeble light rays, and you can do this by either (*a*) holding the film *2* or *3* feet in front of a darkroom safelight for a second or so before you load it into your camera, or (*b*) placing the roll of film in your camera, focusing it at infinity, pointing it at a uniformly colored wall and exposing it at the highest shutter speed. The theory of prefogging the film is that it

gives the emulsion a *head start,* as it is called, and this is done by overcoming its initial chemical inertia. My personal experience with prefogging has been such that I would say it is better to use the films as they are when they come from the makers unless you have the time and money to do a considerable amount of experimenting with it.

Kinds of Pictures to Take.—You can take any kind of a picture with a miniature camera that you can take with any other kind and some kinds that you can't take with the latter. Thus you can take scenic pictures, buildings, interiors, portraits, groups, telescopic, aerial, sports, and action pictures. It is, however, preëminently suited for taking travel pictures and candid shots, and it is also of great photographic value in the several fields of scientific study and research.

Taking Travel Pictures.—In the wide realm of travel pictures you can take them from *railway cars* out of the window, or from the observation platform; you can take the crew, the locomotive, and its engineer. When you take pictures inside of a car you should use a wide-angle lens; when taking them from a car window a standard lens, or, if there is an object in the distance then use a telephoto lens; and always take them at an angle of about 45 degrees from the window and use a high shutter speed. You can take them from the observation platform straight down the receding track.

If you are traveling by *motor-car* you can take even more interesting objects while you are speeding along the broad highway, and take as many shots as you want to for the beauty of using miniature camera film is that each exposure will cost you only a penny or so. What I have said about taking shots from a train car window holds equally good for taking pictures from a motor-car.

When you are sitting in the front seat you can take shots straight ahead through the windshield if necessary, but the latter must be perfectly clean and you must be careful not to get in the reflections from it. For making *stills* when you are motoring you can use a Kodapod or other like camera clamp and fasten it to some part of the car. Traveling by *bus* partakes of the nature

of both the train and the motor-car, and hence what has been said about them also applies to it.

To make an *ocean voyage* is to live in a miniature city that is formed of a thousand or more individuals, each one of whom is a study, and every time everywhere you look you will see a picture that is new and novel and, it follows, one that you should take for your pictorial record of the voyage. Even before you go aboard you should begin to *take* for the dock will teem with life and all of the emotions the human brain is heir to. And these are all yours for the mere taking.

On board you will find a veritable radium mine of *takes* of those lined up in deck chairs, promenading, playing deck games and engaged in swimming and other sports. In the lounge and dining-room are scenes animated and otherwise that can only be taken with a miniature camera. Then there are the steerage passengers who love to be photographed, and a more picturesque lot it would be hard to find—especially if you are making the westward passage. Aye, for candid pictures there are characters who look as if an all-Provident hand had collected them together for your especial photographic benefit and behoof. I'll tell you a little further on how to take a galley full of these remarkable candids.

Then down in the depths of the ship the chief engineer and his staff, on the bridge the commander and his staff, while in foul weather you will find a couple of seamen in the crow's nest, and all of these make never-to-be-forgotten pictures of your voyage. A telephoto lens and a filter will enable you to take sea-gulls that circle round the ship, and if you are sailing in southern seas you will have no trouble in getting some good shots of flying-fish and of porpoises. Finally, if you should be so fortunate, or unfortunate—depending on the kind of a sailor you are—as to run into a real storm you can take pictures of the *mountaineous* waves, as Kipling would call them, breaking over the ship, and they will give you a thrill every time you look at them.

Taking Aerial Pictures.—The term *aerial pictures* means those that are taken from an airplane or an airship and since this mode of transportation has become so commonplace you can get some remarkable views of the terrain below and what is on it. Now while professional photographers use special cameras for taking

aerial pictures you can use any kind of a camera from a Brownie on up.

The quality of the pictures you get, of course, will depend chiefly on (*1*) the kind of a camera you have and (*2*) your skill in handling it. The four chief factors for taking good aerial pictures as far as the camera is concerned, are (*a*) a fast lens, (*b*) a fast shutter, (*c*) a proper filter, and (*d*) a high-speed film.

The miniature is the ideal camera for you to take aerial travel pictures with because it is so compact and, it follows, easily handled. The *lens* can be either a standard *50mm.* or a telescopic *135mm.* one, but while the latter will give larger images there are several adverse conditions that stand in the way of using it; named these are (*a*) that it is more easily affected by the vibration of the motor, (*b*) it must have a proportionately higher shutter speed, and (*c*) since a filter must be used to cut through the haze it is not possible to use as high a shutter speed as it is with the shorter focus lens. So at least in your initial aerial *takes* it is better to use a standard lens.

A high shutter speed is an absolute necessity when taking aerial pictures in order to overcome the swiftness and the vibration of the plane. The best kind of a shutter, therefore, for this class of work is the focal-plane shutter and all cameras that are constructed especially for taking aerial pictures are fitted with this kind.

The focal-plane shutter is not only desirable because of its high speed but also by virtue of the fact that the motion of the shutter can be made to take place in the reverse direction of the object, which in this case is the landscape as it apparently slips along underneath the plane. For these very vital reasons a miniature camera that is fitted with a focal-plane shutter is the best one for you to use for taking aerial pictures.

The Kind of a Filter to Use.—The filter is of the greatest value in cutting down the haze between the airplane and the earth's surface, and you will make but very few trips where you will not have to contend with it, at least to some extent. Now there are two kinds of haze, and these are (*a*) atmospheric haze, and (*b*) city haze. *Atmospheric haze* consists of very fine particles of moisture held in suspension in the air, and *city haze* is com-

posed of particles of smoke, soot, and dust and these are likewise suspended in the air.

Either kind of haze impedes the movement of the light rays through it, but those that produce the sensation of blue and the invisible ultra-violet rays are largely reflected by the particles and these produce the well-known haze effect which cuts off all objects in the distance. To counteract the effect of aerial haze you can use any one of several filters that are made especially for professional aerial photographers, but for general use the ordinary yellow filter will suffice. Gelatin filters cost very little and it is a good scheme to get a number of them of different yellow tints and try them out until you find the one that gives the best results and then you can duplicate it with the more expensive glass filter.

Finally, you can use either (*1*) panchromatic film which is the fastest made but whose grain is not exceptionally fine, or (*2*) orthochromatic film which is not so fast but has an exceptionally fine grain. The latter kind of film makes, of course, the finest enlargements, and prints up to *20 x 24,* and even larger ones can be made from miniature negatives that show practically no diminution of detail.

Having explained the camera requirements for taking aerial pictures let's look a little into the skill you need in handling it. One thing that you don't have to bother about when taking aerial pictures is focusing the camera for all you have to do is to set it for infinity, *i.e.,* beyond *100* feet, when the image of the terrain below will be in focus.

Timing the exposure is something else again, and since there are several factors involved in it, such as distance, haze, etc., the actual intensity of the light is often perplexing. The only way to determine the approximate intensity of the light rays and, it follows, the time of exposure, is to use an exposure meter.

Finally, there are two chief kinds of planes that you can fly in, and hence take pictures from, and these are (*a*) the open cockpit plane and (*b*) the cabin plane. The *open cockpit plane* is the kind that is in general use for taking passengers up for the fun and the thrill of the thing, while the cabin plane is the kind that is used for actual transportation purposes.

Now it is a simple matter when you are in an open cockpit plane

to look over the side at the terrain below, then point your camera toward the area you want to take the picture of and make the exposure. Not so, however, with the cabin plane for the windows are usually made of shatterproof glass and cannot be opened, so the only thing to do is to hold your camera close to it [2] at an angle of about 45 degrees and take the picture through it. To exclude interior reflections you can hold your camera close to your body. Lastly, the best vantage points to take pictures from in a cabin plane is the front or the rear seats as the view from there is the best that you can get.

Taking Candid Pictures.—The word *candid* means *free from undue bias,* that is *without partiality* or *prejudice,* and a *candid picture* means, therefore, one that is taken of a subject without his or her knowledge and, it follows, it is an unposed one. Candid pictures had their origin when Dr. Erich Solomon, of Germany, made miniature camera shots of various world famous diplomats when they were talking to each other at the *League of Nations* conference in Geneva in *1924, unbeknownst* to them, and thus a new kind of portrait photography was born.

These unusual pictures were published in various English magazines under the caption of *Candid Photographs,* and they immediately caught the public fancy by their very spontaneity; then enthusiasts all over the world became interested in the miniature camera and took up with avidity the new art of photographing their subjects while the latter were in blissful ignorance of it. The great charm of candid photography is to take your subjects when they are in the act of doing something that is characteristic of them.

The Equipment You Need.—Naturally the smaller and more inconspicuous the camera the easier it is to take pictures of subjects at close range without their knowing it, and a miniature camera fulfils this condition to a meticulous nicety and so this is, obviously, the kind you should have for taking candid shots.

Now while almost any lens that comes as an integral part of the miniature camera is fast enough for taking candid shots outdoors you must have a much faster lens—yes, the fastest lens—

[2] Do not let the barrel of the lens touch the window for the vibration of the plane will then be transmitted to your camera.

for taking them indoors, and, unfortunately, it is usually there where the best subjects are to be found in action and, of course, the lighting conditions the poorest. For this class of candid shots you should, therefore, have the fastest lens you can get, *i.e.*, one with an *f.1.4* or an *f.2* aperture.

It is not always necessary to get so close to your subject that he would suspect you were taking a picture of him if he chanced to see you, for if you are in the open or in a large room you can use an angle finder (see *Chapter VIII*, page *125*), or a telescope lens, and to great advantage, for then you are apparently not looking at him or are so far away from him he wouldn't have the remotest idea that he is your quarry. With a telephoto lens you can stand *20* feet or more from your subject and take a candid picture of him provided, of course, the line of sight in between is not obstructed.

Some Useful Accessories.—There are several accessories that will be of material assistance to you when you are taking candid pictures and chief among these are (*1*) a lens shade, (*2*) an angle view finder and, occasionally, (*3*) a tripod, and here are the conditions when you want to use them.

As I have said in the foregoing chapters, you should always use a *lens shade* on whatever kind of a lens you may have except those in the small fixed and adjustable focus cameras, but it is an absolute necessity when you are taking candid pictures. Curiously enough, the larger the aperture of the lens, *i.e.*, the faster it is, the more it tends to produce *flare spots*. Even when the lighting conditions are as you like them a lens shade will keep out the extraneous light rays and hence it will increase the brilliancy of your pictures.

The *angle view finder,* which I have previously described, is a useful little gadget for your candid camera equipment for it will enable you to take a picture of a subject while you are standing close to him and yet he will not know it.

The way you do it is like this: Every one knows that when you take a picture you stand facing the subject and look through the finder directly at him. With the angle view finder you hold the camera so that the lens is pointing at the subject but when you focus it you stand so that you are looking at right angles

away from him and this hoodwinks him into the belief that you are taking the picture of some one else.

In taking almost any kind of a picture a *filter* is of the greatest value, except when you are making candid shots; this is because it (*a*) tends to tone down the facial lines and defects, and (*b*) increases the exposure from 2 to 4 times as against when it is not used. If, however, your subject is under the glare of a powerful light you can use it with good effect. In this case you should use a *Wratten Series K-1* light yellow filter, which has a fairly good corrective power, and requires about double the normal exposure with a panchromatic film.

Lastly, the usual conspicuous floor tripod is entirely out when it comes to making candid shots, but there is a little *table tripod* that you can set up anywhere, and you can often use it where you have to make an exposure that is longer than 1/25 of a second. It is made of metal and has leveling and tripod screws so that you can attach it to your camera, set it up and level it in a moment's time.

If you are interested in miniature camera photography either as a hobby or for monetary gain you should by all means join the Miniature Camera Club, New York City, and subscribe for the *Minicam Magazine*, 22 East 12th Street, Cincinnati, Ohio, which it publishes.

CHAPTER XV

HOW TO TAKE PRESS PICTURES

THE TERM *press pictures* means pictures of any and every kind that you take for the newspapers, magazines and all and other sundry publications. Now photographs that you take for the press must not only be good in themselves but they must have either (*1*) a definite pictorial appeal, (*2*) be an exclusive feature, or (*3*) of timely interest.

About Selling Press Pictures.—It has been ascertained by our *Bureau of Investigation,* as my friend Damon Runyon would say, that over one-half of all the photographs that are bought by the editors or heads of the art departments of the various publications in the United States are made by the amateur camera shooter, and whose real means of livelihood is obtained from some other and, usually, quite a different line of endeavor.

Now selling pictures to the editor of a publication is on a par with selling articles or stories to him, in that first of all they must fit into the particular policy of his paper or magazine. Thus it is obvious that it would be the height of folly to offer the editor of *Popular Mechanics* a picture of Mayor LaGuardia in action at a pow-wow, or the editor of *Esquire* or the *New Yorker,* one of Professor Lawrence producing artificial radium with the cyclotron.

So if you are a novice in the game I would suggest that you go to a public library, look over all of the trade papers and popular magazines there, and ascertain which ones use the kind of pictures you want to specialize in. Having found one that your pictures are appropriate for send or, better, take them in to the art editor and he will speedily tell you if he wants them or not. If he says he can't use them don't even ask him why. If he is sufficiently interested to criticize them, listen but don't argue—much less get *sore*—for the editor is always right. Above

all don't get discouraged but keep right on making pictures and submitting them to him until he finally takes one—*just one,* that's all you want—for it will be the opening wedge, and then you can sell others to him right along.

The late John D. Rockefeller once said it is the first *$100* that is the hardest to get; Arthur "Bugs" Baer, the columnist, tells us that it is the first *100* years that is the hardest to live through, and I'm telling you it's the first picture, article, story, book, or what have you, that is the hardest to unload on an astute editor. Having sold him the first picture each succeeding sale will be easier than the one before it with the final result that you will be a regular contributor, and, perhaps, even made a member of his photographic staff (I hope!).

The pictures that you submit to an editor must not be smaller than *4 x 5* inches, a *5 x 7* one is better and an *8 x 10* is still better, for the larger it is the more clearly the details of it will show up, with the result that when you place it before him he will instantly be able to grasp the import of it. After the subject itself and your mode of treatment you will find that the size of the picture is a considerable item in putting it over.

This is the day of fine-grain films, fine-grain development, highly specialized print papers, the ease with which you can make enlargements, and the perfection of them. However small your negatives may be always make *8 x 10* enlargements of them, when your chances for disposing of them will be proportionately increased.

The Prices of Press Pictures.—The prices that you will be able to get for your pictures will depend very largely on (*1*) the kind they are, and (*2*) on the publication that takes them. Trade papers and the ordinary run of magazines will, in general, pay you *$2.00* or *$3.00* for each one, while the better class of magazines will pay from *$5.00* to *$50.00,* and occasionally even *$100.00* or more for each one. In order to get these *crotcheted* amounts for your work, however, they must have conspicuous merit such as (*a*) an outstanding subject, (*b*) extraordinary pictorial treatment, (*c*) an exclusive feature, or (*d*) a scoop.

Kinds of Press Pictures.—Any kind of a picture is a *press picture* if it is of interest to the readers of a paper or a magazine.

Now I have explained in the preceding chapter where to find and how to take all kinds of pictures and it is my intention now to tell you how to take exclusive feature pictures. The term *exclusive feature picture* means those that (*a*) no other press photographer has taken, or (*b*) if he has taken them that yours are better than his.

Kinds of Exclusive Feature Pictures.—There are numerous kinds of exclusive feature pictures as, for example, those of motor-car accidents, railway train wrecks and airplane crashes, fires, floods, and cyclones, riots here and battles there, principals and witnesses in murder, divorce and other trials, persons who are in the public eye—and you can *shoot* these in the court-room or, easier, when they are arriving from or leaving for anywhere, be it Hollywood, Reno, or Alcatraz Island, *et cetera.* These are just a few of the many possible exclusive feature pictures that you can get if you have the qualifications of a press photographer.

The Qualifications You Must Have.—The five chief qualifications that you must have if you are going to be a successful press photographer are (*1*) to be a good cameraman, (*2*) a a quick-witted thinker, (*3*) have unadulterated nerve, (*4*) be willing to risk your neck for the sake of a picture, (*5*) have a total disregard for policemen and other officers of the law as long as you can get away with it,[1] and, lastly, (*6*) be a gentleman when you step out of character, *i.e.*, that of a press photographer. If you have the first five qualifications I doubt very much if you will possess the sixth and last one, but which, in the analysis situs, doesn't very much matter anyway.

Kinds of Press Cameras.—The three chief kinds of cameras that are especially adapted for taking press pictures are (*1*) the miniature, (*2*) the Speed Graphic and (*3*) the Graflex. While the miniature camera is in its infancy as far as press photography is concerned it stands at the head of the class when it comes to taking candid pictures where (*a*) the lighting is poor and (*b*) it is necessary not to attract the attention of the subject.

While candid photography for the mere fun of the thing is quite a simple matter inasmuch as you can take the pictures where and when you please, for press work it becomes a serious

[1] A reporter's *press card* will help you a lot.

and often a difficult job, especially if you are working on a newspaper, for when you are sent out to *get your man,* get him you must under any and all conditions, or else—!

The fact that the miniature camera is fitted with the fastest lens—an *f.1.4,* or an *f.2*—makes it possible to take pictures in poorly lighted rooms where you have to do so secretly as, for example, in a court-room where you must get candids of the accused and various important witnesses. Candid pictures of the late Bruno Richard Hauptmann when he was on trial for murder in the Lindbergh baby kidnapping case were taken in this way. Taking pictures of this kind is prohibited in court and if the photographer is caught in the act he can be fined, sent to jail, or both.

Both the *Contax* and the *Leica* miniatures can be fitted with a synchronized photoflash light unit, so that you can take pictures anywhere and at any time—provided, of course, there are no legal obstructions in the way—and this regardless of what the lighting conditions may be. When you take photoflash-light pictures, however, they will no longer be candids for your subject or subjects will be fully aware of what you are doing.

Photoflash-light pictures of those who are in the public eye, are the kind that you usually have to be satisfied with where you are barred from taking them in court and in other inaccessible places. You will then have to take them as they are going into or coming out of their homes, hotels, offices, and courts, and getting on and off of trains, steamers, and airplanes.

The trouble with taking photoflash-light pictures is that many of your subjects are camera-shy, due to any one of a number of reasons, and so hide their faces if possible by holding their hands, a newspaper, a hat, an umbrella, or other object up to them.

The *Contax Olympic Gun,* which is pictured in *Fig. 84,* was used by miniature press and sports photographers in covering the Olympic Games to take close-ups of the events. It consists of (*a*) a Contax camera, (*b*) a Zeiss Sonnar *f.2.8* telephoto lens that has *180mm.* (*7*-inch) focal length and (*c*) a support for them in the form of a rifle stock, and the shutter is operated by a trigger like that of a rifle. The telephoto lens has a very

large aperture, and the gun is preëminently the press and sports photographer's long-range equipment, as it will produce a correctly exposed negative of a fast-moving object even under difficult lighting conditions.

The Speed Graphic and the Graflex cameras have the advantage of the miniature camera in that they take larger pictures but the comparatively large sizes of them pretty well preclude the

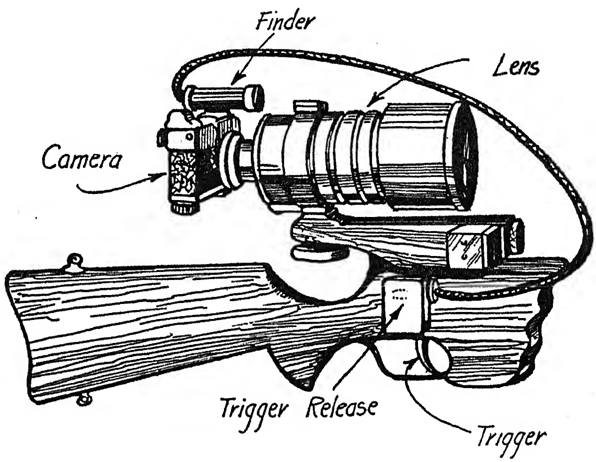


FIG. 84.—THE CONTAX OLYMPIC GUN

(Contax camera with f.2.8 Sonnar lens. It covered the Olympic Games, taking close-ups of the events.)

possibility of taking actual candid pictures. Like the miniature cameras the Speed Graphic and the Graflex can be fitted with a synchronized photoflash-light unit, that is, one which operates simultaneously with the between-the-lens or the focal-plane shutter.

To my way of thinking the Graflex is better than either the miniature or Speed Graphic cameras for the reason that you can see at all times the full-sized image of the picture you are going to take just as it will appear on the plate or film. Notwithstanding the several advantages that the miniature camera has over the two above-named ones there are very few press photographers who use it at the present time.

Again, Know Your Camera.—In the preceding chapter I told you that in order to take the best possible pictures with a miniature camera you must not only know all about it but also how to make all of the mechanical adjustments without giving them the slightest thought, *i.e.*, to make them automatically, for then, and only then, will you be able to give all of your time and cogitation as to the best way to take your subject. And, naturally this also holds good for the *Speed Graphic* and the *Graflex*.

About Making the Pictures.—After you have taken the pictures of your subject you must develop and fix the film and make the prints. If you are a rank amateur you can, of course, have this done at some processing shop, but if you are a really serious free lance, or on the staff of a paper or a magazine, you must be able to do these chores for yourself.

To develop and fix the film you will need a darkroom, a tank, a developer, and a fixing solution, and to make prints from the negatives you will need an enlarger, some sensitized paper, a developer, and a fixing solution, and all of these things and the way to manipulate them will be treated under their respective headings as we push along.

CHAPTER XVI

HOW TO TAKE SCIENCE PICTURES

As you probably know *science* is the classified facts and principles of the material universe and its related phenomena. Now there are numerous branches of science but the chief ones that you can use a camera to advantage with are (*1*) microscopy (pronounced mi-*cros'*-co-pe), (*2*) astronomy, (*3*) entomology, and (*4*) physics. You can take science pictures with almost any kind of a camera provided it is fitted with the proper lens, but the miniature camera is particularly adapted to the needs of the amateur by virtue of (*a*) its compactness and (*b*) the number of pictures you can take without reloading it.

How to Take Photomicrographs.—As its name indicates the *microscope* is an instrument that produces an enlarged or a magnified image of a small object. Now while a single convex lens or a doublet will produce an enlarged image of a small object, since the magnification is only a few diameters, such a lens is usually called a *magnifying glass*, or just *magnifier* for short.

Properly speaking a *microscope* is a combination of lens components and these are (*a*) the objective or object glass and (*b*) the ocular or eyepiece. These lenses are mounted in a tube or *barrel*, as it is called, and this, in turn, is pivoted to a heavy base.

Now when you place a very minute object on a glass slide under the *objective* and focus the *ocular* so that it will form a sharp image on the retina of your eye you will see an enormously enlarged image of it.

As far as I have been able to find the first scientific use to which the camera was put was taking enlarged pictures of insects. This was just *100* years ago, when J. B. Read, of England, succeeded in taking a picture of the magnified image of a flea by

connecting his camera to a low-power microscope. Since his time great strides have been made in the design and construction of microscopes[1] and of cameras, and it is now possible to take a picture of a microscopic object that is *100,000* times or more larger than the latter.

For taking *photomicrographs,* or *microphotographs,* or just *micrographs* as they are called for short, you must have (*1*) a

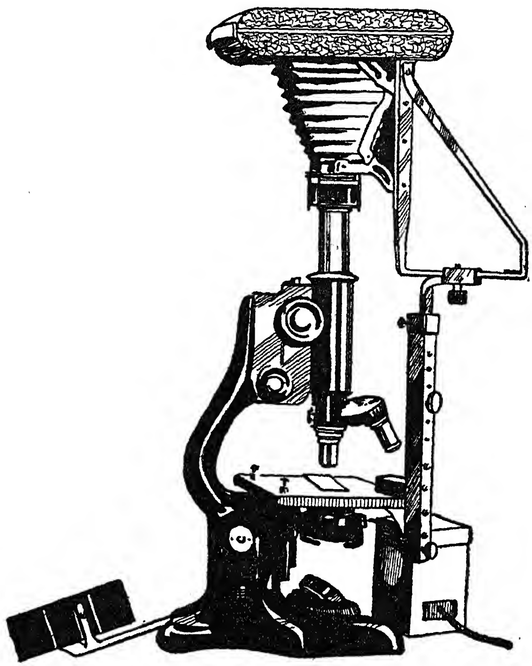


FIG. 85.—THE CAMERA MOUNTED ON A MICROSCOPE

high-power microscope, (*2*) a camera and (*3*) a support for it. The microscope can be of any kind but, of course, the finer it is the better will be its resolving power, *i.e.,* its ability to render visible and make clear the separate parts of the object you are taking the picture of.

The camera can also be of any kind but it must have a ground-

[1] If you are interested in microscopy you should read my *Book of the Microscope,* published by *D. Appleton-Century Co.,* New York, and London.

glass screen so that you can sharply focus the image of the object. If you use a small bellows camera you need only to remove the lens from the barrel and connect it with the eyepiece of the microscope. To use a miniature camera you must connect an *extension tube* that is about $2\frac{3}{8}$ inches long between the camera and the microscope.

The Eastman Company makes a support for the camera that is called a *Microdak* and this is clamped to the stage of the microscope as shown in *Fig. 85*. If you use a miniature camera you can get a Leica *sliding focusing attachment* to hold it rigidly to the microscope.

To take sharp micrographs both the microscope and the camera must be perfectly rigid for the slightest vibration will be magnified and so spoil the picture. When you focus the image have it as sharp as you can possibly get it and be careful that there is no jarring movement of the shutter. You can use either sunlight or electric light to illuminate the object that is mounted on the slide and it (the object) should be stained in order to bring out the separate parts of it to the best advantage.

How to Take Photoastrographs.—*Astronomy* is the science of the sun, moon, planets, and other heavenly bodies. The first to photograph the stars was W. C. Boyd, of England, who in *1850* took a picture of the two bright stars *Castor* and *Pollux* in the constellation of *Gemini the Twins,* and then in *1864,* Rutherford, of England, took some pictures of the *Pleiades,* the small but conspicuous cluster of stars [2] in the constellation of *Taurus,* the *Bull.*

It was not, however, until the dry plate was introduced in *1878* that *astronomical photographs, photoastrographs,* or just *astrographs,* as they are called for short, began to take the place of the telescopic drawings that were made by astronomers. The first outstanding astrographs were taken of the great comet of *1882* at the Cape of Good Hope observatory which was then under the direction of Sir David Sill. At the present time photography has all but superseded eye observation through the telescope.

[2] Six stars can be seen by the average eye, but with a telescope many hundreds more are visible.

Now while you can take a picture of a heavenly body with an ordinary camera and lens it will be of no value because all you will get on the plate or film will be a circular white line. To take photographs of the heavenly bodies you must have (*1*) a telescope so mounted that you can either (*a*) operate it by hand or

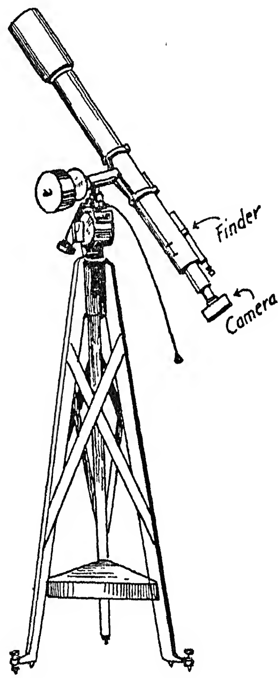


FIG. 86.—THE CAMERA MOUNTED ON A TELESCOPE

(A Zeiss 3⅛-inch telescope with spring-driven clockwork.)

(*b*) have it driven by clockwork, to counteract the motion of the earth, and (*2*) a camera.

There are two kinds of telescopes and these are (*a*) the refracting telescope and (*b*) the reflecting telescope. The difference between these telescopes is that the *refracting telescope* has a large lens, or objective, that forms the image, while the *reflecting telescope* has a slightly concave mirror that forms the image.

You can use either of these kinds of telescopes for taking astronomical pictures and any kind of a camera but it must have a ground-glass screen so that you can sharply focus the image of the object. Before you fit the camera to the eye-end of the telescope you must remove the lens of the former and the eye-lens of the latter. A camera fitted to a manually operated telescope is pictured in *Fig. 86*. To take a picture of a heavenly body you must focus the image of it as sharply as possible on the ground-glass screen and then change it for a plate or a film. If you take a picture of the sun you must use a deep red filter in front of the object glass of your telescope and a very small stop in the barrel of your camera lens, and then give it a very short exposure—say about 1/200 of a second.

To photograph the moon or the planets you do not need to use a filter or a stop but you must give the plate or film an exposure of *30* minutes or more, and when taking pictures of the fixed stars you can increase the time of exposure to upwards of three hours. The longer you expose the plate or film the brighter will be the stars; this is due to the cumulative effect of the light rays from them on the plate or film.

To take sharp pictures of the moon, planets, and fixed stars with a manually operated telescope is a very difficult thing to do because you must keep your eye constantly at the finder and accurately make the manual adjustments that are necessary to hold the image of the object on the same point of the plate or film. You must also do this with an equatorial clock-driven telescope for while it is sufficiently accurate for observing the heavenly body with the eye it is not so when you are taking pictures with it.

How to Take Entomological Photographs.—Reduced to its lowest common expression *entomological photographs* mean *insect pictures*. In popular usage the word *insect* means any kind of small invertebrate animals that have long bodies which are separated by a narrow waist. There are, roughly, *22 orders of insects*, and these are divided into from *1* to *80* or more *families*; these, again, into from *1* to over *1,000 genera* and, finally, these into from *1* to *3,000 species*. Wherever you live you will have no difficulty in finding an abundance of insects; thus there are

over *15,000* species of insects to be found within a *50*-mile radius of New York City, and of these there are more than *2,000* species of butterflies and moths.

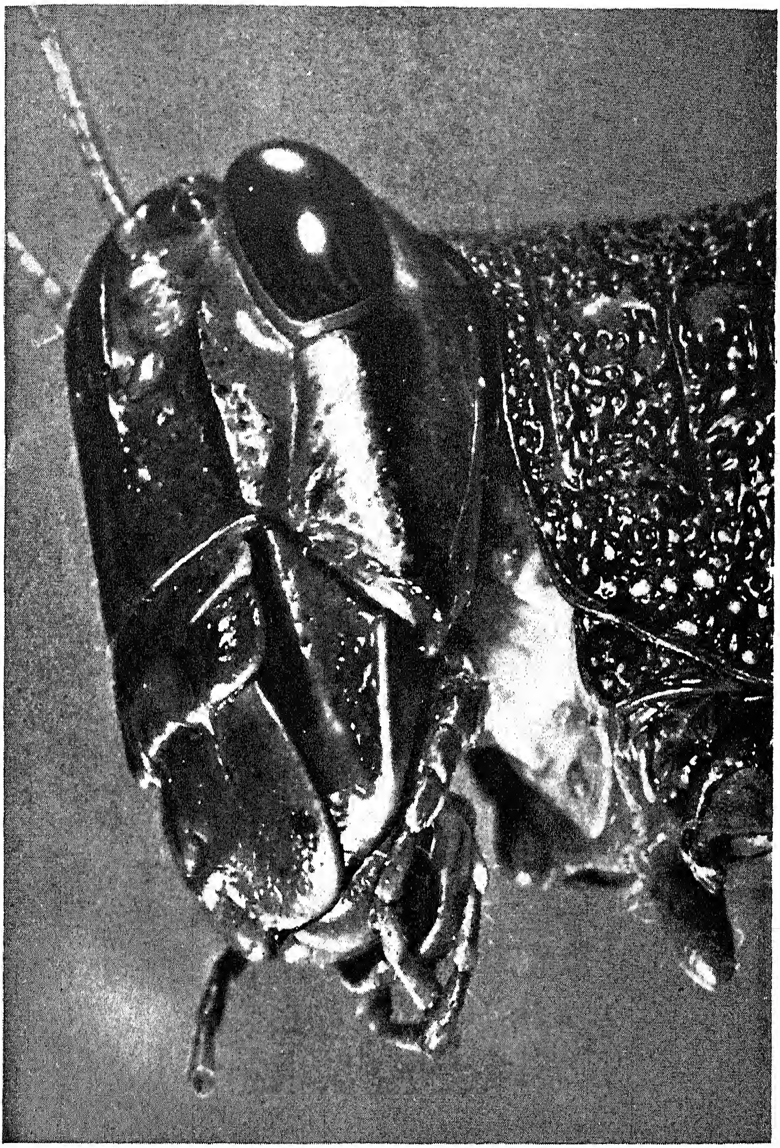
There are two ways to take pictures of insects and these are when they are (*1*) dead and (*2*) alive. To photograph insects when they are *dead* is the easiest but not the most realistic way, but if this is your idea of it you will have to go out in the mild months of the year and collect and prepare them for subjects. You can keep them until winter time, if you want to, and then take pictures of them at your leisure. Oppositely if you photograph them when they are *alive* you must needs do so in the field and when it is approximately the good old summertime.

The Equipment You Need.—To take good pictures of insects either at home or in the field your camera must be fitted with a ground-glass focusing screen. A miniature camera is particularly well adapted for this class of work and it is now made with a *sliding focusing copy attachment and magnifier.*

Should you use a miniature camera the distance between the lens and the ground-glass screen must be capable of being adjusted so that either a reduced, a life-size, or an enlarged image of the subject can be had. This is because some insects, such as the mosquito and fly, are so small the images of them must be enlarged in order to bring out the finer details, while others, such as the grasshopper and butterfly are so large you must reduce the images of them in order to get them on a *35mm.* film.

If you use a miniature camera you will need besides the focusing copy attachment and magnifier a set of *30mm., 60mm.,* and *90mm.* extension tubes, a *35mm.* and a *50mm.* lens, a lens shade, a tripod, and a ball-jointed tripod head. Naturally the kind of film that is best adapted for taking pictures of insects is the super-speed (*SS*) pan; the lens should be stopped down to about *f.16,* and the exposure will then range from $\frac{1}{20}$ to *1* second depending on the lighting conditions.

Taking Insect Pictures Indoors.—The first thing you must do is to catch the insects that you want to photograph and preserve them. I can't go into the details of how to do these things here, but if you will send to the *Secretary* of *The American Museum of Natural History,* New York City, for a copy of a leaflet called



GRASSHOPPER'S HEAD

(By Florence Stuck. From Fourth International Leica Exhibit. Leica camera; Hector lens with copy attachment; E.K. background film.)

How to Collect Insects, which I believe is free, he will mail a copy to you.

Should you be interested in entomology as well as photography and you want to know all about insects, that is, what class, order, genera, and species they belong to and their life histories, then get a copy of Dr. Frank E. Lutz's *Field Book of Insects.*[3] Dr. Lutz is the Curator of the Department of Entomology of the American Museum of Natural History and he is one of the foremost authorities on *Insecta.*

After you have caught the insects that you want to take pictures of you can kill them painlessly by putting them in a bottle that contains some ether or carbon tetrachloride, and you must mount them as soon as you get home. To do this so that they will look perfectly natural is not an easy job but a little intensive practice and a lot of extensive patience will enable you to do so.

When at any time you want to take a picture of a cricket, a grasshopper, or other large-sized insect you can build up an artificial habitat for it by using a sheet of white or black paper for the background and then build up the foreground with bits of moss, grass, leaves, twigs, and the like, while a small mirror, with the edges of it concealed, of course, will serve admirably for a pond. Compose these things so that the setting will look as real as possible.

You are ready now to pose the subject and this you can do by placing it against some object that forms a part of the set or you can support it with bits of fine wire from the rear so that they will not show in the picture. When you have posed the insect so that it looks as real as it did in life and twice as natural, or at least half as natural, you are ready to focus the image and make the exposure.

Taking Insect Pictures in the Field.—While there is little or no insect life in well-regulated homes the great outdoors teems with it and so this is your happy hunting ground. Now to take a picture of living insects in their native haunts is not at all an easy thing to do because (*a*) it is often hard to get close enough

[3] Published by *G. P. Putnam's Sons,* New York City, and the price of it is $2.50.

to do so without frightening them away and (*b*) they are constantly on the move. In either case it frequently happens, no matter how cautious you are, that when you have your camera set up and carefully focused your subject will have disappeared.

Now there is a middle-of-the-road way to take a picture of the insect, and that is when it is neither fully alive nor yet quite dead, and this is done by the simple process of anesthetizing it. To photograph it this way is easy and it will not only remain

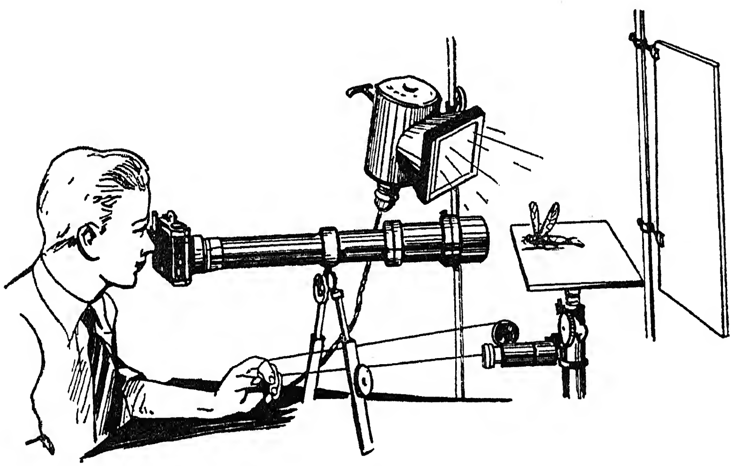


FIG. 87.—TAKING A PICTURE OF AN ENTOMOLOGICAL SUBJECT

put but it will look perfectly natural. The first thing to do is to pick out a twig, leaf, or some other appropriate place where you want to take its picture, and then set up your camera and focus it on the spot you have chosen.

This done catch the insect and put it in a wide-mouth bottle that contains a few drops of either ether or carbon tetrachloride. Watch it closely while it is being anesthetized and remove it from the bottle the moment it has succumbed. Lastly put it on the spot your camera is focused on and pose it by means of a fine needle; again see if the image of it is sharp and, finally, make the exposure.

If you have anesthetized it to the proper degree it will not recover from the effects of it for a minute or two and just as it

does so is the time to make the exposure for then it will assume its life-like look and natural attitude, but it will not yet be imbued with enough vital energy to make a quick get-a-way.

How to Take the Picture.—In setting up your camera the best angle for photographing the insect must be considered just as it is for taking the picture of any other subject, and this is usually about *45* degrees or else take a side view of it. The next important thing is to have your camera on, or very nearly on, a level with the insect as shown in *Fig. 87*.

Lighting an insect subject outdoors is not a simple matter but it follows the same general rule as lighting a human one, and it often requires considerable ingenuity to obtain the necessary contrast. For indoor lighting you can use almost any kind of illumination but good results can be had by using three Mazda lamps with reflectors back of them. One of these can be placed a little in front and above the subject and the other two on opposite sides of it.

Or, if you prefer, you can use a couple of flood-lights with muslin screens in front of them on opposite sides of the insect to provide a bright and even lighting, and then project a spotlight on it to produce the needed contrasts. Where a very small insect, such as a flea or a fly, is used as the subject, to light it so that the details of it are fully brought out you will have to use the rule of trial and error method.

How to Take Infra-red Ray Pictures.—As I have previously explained *infra-red rays* are formed of waves in the ether that are just a little longer than those that produce the visual sensation of red and, hence, they are too long to be sensed by the eye. You will remember that in Chapter XIII "How to Take Pictures At Night," I described a method of photographing a subject by flooding him with infra-red rays and, it follows, the room is quite dark to the eye since there are no visible light rays in it. As a matter of fact, however, the worst possible way to take a picture of a person is to use infra-red rays as you will presently see, but, oppositely disposed, they are of the greatest value in photographing other things, as you will also see if you will but read on.

First of all you must know that infra-red rays possess two characteristics that light rays do not have, and these are (*1*)

they will penetrate certain materials that light rays cannot pass into, and (2) they are strongly reflected by various substances that absorb light rays. This is the reason infra-red rays will penetrate atmospheric haze, and why infra-red filters and films are used when taking landscapes and aerial pictures. It is also the reason they give sensational contrasts to trees and other foliage and make them look as if they were in blossom.

Why Infra-red Ray Portraiture Is Out.—As I have mentioned above infra-red rays have the power to penetrate various materials that rays of the visible spectrum cannot pass through. Thus certain kinds of wood, such as pine, sycamore, etc., are penetrated by them to a depth of $\frac{1}{8}$ of an inch or so. On the other hand they will not penetrate woods like oak, walnut, etc.

They will, however, pass readily through the human skin and to a considerable depth with the result that the details of the flesh under it, and which it is impossible for light rays to reach, are made clear when a picture is taken of a person. Thus when a subject is photographed by infra-red rays you do not see the beauty that is skin-deep but the processes that are under it, and this makes the picture of him look quite strange and often positively awful. For this very valid reason taking portraits with infra-red rays are *out* with a capital *O*.

Infra-Red Rays in Criminology.—In the field of detecting documents that have been changed and forgeries of various kinds, infra-red photography is in a class by itself. The way that they are used is to take a picture of the altered document or forged paper with them when it will show the original words and names on it before they were changed.

A picture taken this way of the painting of an old master will also show any changes that have been made on it since the new and the old pigments, while they look precisely the same to the eye, will take on very different tones when photographed. One of the most important uses in criminology is to ascertain the original number that is stamped on a pistol or other firearm by the manufacturers after it has been filed off by the gunman. When a picture is taken of it through an infra-red filter and on an infra-red film the original number will show up clearly enough so that it can be easily read.

Infra-Red Rays in Photomicrography.—In taking pictures of insects with infra-red rays it has been found that they penetrate the *chitin* which forms the harder parts of the covering of the bodies of insects, and make the cells underneath it visible. Even when you are taking a picture of an insect whose integument is dark and opaque to light waves, as certain kinds of beetles, the infra-red waves will pass through it as easily as X-rays pass through leather or wood.

Infra-red Rays in Photoastrography.—When taking pictures of the heavenly bodies, or *astrography* (pronounced as-*trog'*-ra-fe), to give its scientific name, additional value is sometimes given by doing so with infra-red rays and infra-red films, and this is especially so when photographing a planet. In this case the infra-red rays penetrate the haze of the planet, when the image of the surface will then be impressed on the plate or film instead of the atmosphere when it is photographed with visible light.

How to Take Ultra-violet Ray Pictures.—I explained in one of the earlier chapters that *ultra-violet rays* are formed in the ether and that they are a shade shorter than those that produce the visual sensation of violet, hence they are too short to be sensed by the eye. When you want to take a picture of a small object or a subject in which the finest details must be brought out, as for example an insect, all you need to do is to flood it with ultra-violet rays.

A simple and most effective way to set up ultra-violet rays is to use one or more *black blub mercury vapor lamps.*[4] These lamps will screw into standard-lamp bases, and each lamp takes *15* volts and from *2* to *5* amperes to energize it according to its size. While ultra-violet rays have a high resolving action on a plate or film, you need have no fear of using them as they have no untoward effect on the eyes.

The light rays that are produced along with the ultra-violet rays by the black-bulb lamp are so feeble that they are hardly visible and, hence, when you focus the object you must do so with white light, *i.e.,* rays from a Mazda lamp or other common source. When you are taking pictures with black-bulb lamps you

[4] These are made by the *General Electric Vapor Lamp Company,* Hoboken, New Jersey.

should use two of them—one on either side of the object—and it is often a good scheme to use a third one in front of and a little above the subject.

By using reflectors with the lamps you can materially cut down the time of exposure. Ordinary reflectors are, however, of but little use, the best kind being those that are made of aluminum and which have a matte surface. You can easily do this by immersing ordinary aluminum reflectors in a dip made of a strong solution of sodium hydroxide, or *lye* as it is commonly called. In doing so, however, be careful not to breath the fumes of it.

In taking pictures with ultra-violet rays you must greatly increase the time of exposure as against that required when you are using light rays—a hundred times or more. On first thought this may seem a little strange since ultra-violet rays have such a powerful actinic action, but the reason is quite simple and it is this: ultra-violet rays pass freely through quartz and the tubes of the black-bulb lamps are made of this material, but they are largely cut off by the glass of which the lenses are made and, hence, a longer exposure is required. In taking pictures with ultra-violet rays you should, of course, use a super-speed panchromatic plate or film.

How to Take X-Ray Pictures.—In *1895* the world and his wife were properly set by the ears when Wilhelm Konrad Röntgen, German physicist, announced that he had produced a new kind of rays which penetrated wood, leather, and flesh, but which were stopped by bone, the metals, and other dense substances.

These rays are like those of light in that they excite fluorescent substances and act chemically on photographic plates and films, and yet they are unlike light rays in that they are reflected but feebly and are not refracted by prisms and lenses; and so because he did not know the nature of them he called them *X-rays,* since *X* is the *math* symbol that is generally used to indicate an unknown quantity.

Through the investigations of Max von Laue, also a German physicist, in *1913,* and Sir William Bragg and his son, W. L. Bragg, of England, in *1922,* it was found that X-rays were formed of waves in the ether that were like light waves, but which were

approximately *1,000* times as short as the shortest wave length of ordinary light waves, *i.e.*, visible light.

The Apparatus You Need.—A photograph made by X-rays or *radiograph* as it is called, is not an image of the object such as you would make with a lens but simply a shadow picture of it,

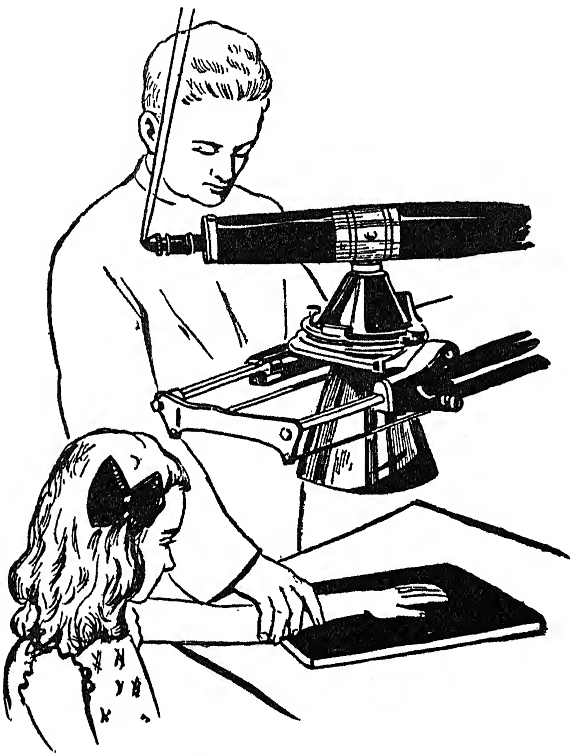


FIG. 88.—TAKING AN X-RAY PICTURE

and for this reason a camera is not needed to take it. The apparatus for taking X-ray pictures is shown in *Fig. 88,* and it consists of (*1*) an induction coil, or other source of high-tension current, (*2*) an X-ray tube and (*3*) a plate or a film in a light-tight holder, or an opaque envelope.[5]

[5] You can get the necessary apparatus for taking experimental *radiographs,* as X-ray pictures are called of the *Central Scientific Co., 1700* Irving Park

To take an X-ray picture you need only to connect a battery or other source of low-voltage current, to the primary terminals of the induction coil, and the X-ray tube to the secondary terminals of the coil. Lay the plate holder or opaque envelope that has the plate or film in it on the table, then place the object you are going to make the radiograph of flat on top of it, adjust the tube above it at a distance of *6* inches or more depending on its size, and so that the rays which are set up by it will be projected down through the object and onto the plate or film, and then switch on the current.

The time of exposure depends chiefly on (*a*) the power of the tube and (*b*) the kind and thickness of the material of the object you are going to make the X-ray picture of. After you have made the exposure, develop, fix, and wash the plate in the usual way, and make a print of it.

Boulevard, Chicago, Illinois, or professional equipment of the *General Electric Company,* Schenectady, New York.

CHAPTER XVII

HOW TO TAKE THREE-COLOR PICTURES

When you look at the image of an object, a person or a landscape that is formed by a lens on the ground-glass screen of a camera you will see it in colors that are exactly like those of the original. Now ever since the camera was invented it has been the conatus of photographers to make pictures which would retain the natural colors of the image and, hence, of the original.

The making of black and white pictures is a comparatively simple process since the chemical change in the silver salts of the plate, film, or paper is due to the action of the light rays on them, while making photographs in their natural colors is an infinitely harder thing because there is no way known at the present time by which the various colors that form the image can be fixed by chemical action. It is, however, possible to make color photographs on both plates for transparencies and lantern slides, films for moving-picture projection, and on paper, *i.e.*, paper prints, by certain mechanical arrangements of the colors.

The Invention of Color Photography.—*The Theory of Color Sensation.*—It was Sir Isaac Newton, of England, in *1666,* who first showed that the light rays from the sun produced distinct colors, and this he did by splitting up a beam of light from the sun by means of a slit and a prism which I described in *Chapter II.* This and succeeding experiments in the analysis and synthesis of the rays that set up what we call *white light* led physicists and physiologists to try to find out how light waves acted on the retina of the eye and the visual center of the brain and so produce the various sensations of color.

These investigations resulted in several theories to logically account for them but the accepted one by physicists and which experimental evidence confirms is known as the *Young-Helmholtz theory,* since Thomas Young, a physicist of England, in *1807,*

first enunciated it, and then von Helmholtz, a physicist and physiologist, of Germany, in *1843,* modified it. In brief their theory assumes that there are three distinct sets of nerves in the central region of the retina of the eye, and that one of them responds only to light wave lengths which set up the sensation of *red* in the visual center of the brain, another one to wave lengths that set up the sensation of *green,* and the remaining one that sets up the sensation of *blue,* or more precisely *blue-violet.*

All of the other colors of the visible spectrum, and all of the complementary colors are produced by simply superposing these

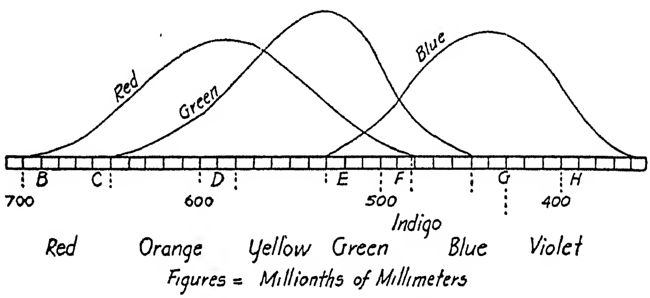


FIG. 89.—ABNEY'S COLOR SENSATION CURVE

(Showing how overlapping primary color wave lengths set up the other colors of the spectrum.)

three wave lengths one on the other that form the primary sensations of red, green, and blue-violet. Not only are three different wave lengths needed for producing the primary and complementary colors but by superposing them in the right proportions any tint or shade of them can be produced, and this is graphically shown by Abney's color sensation curve in *Fig. 89.* To set up the sensation of *white light* you need only to superpose the red, green, and blue-violet waves in the proper ratio while *black* is, as you know, the absence of light rays of any kind.

The First Three-color Photograph.—The first to prove the truth of the Young-Helmholtz three-color vision theory experimentally was James Clerk-Maxwell, a mathematical physicist of England, and this he did in *1861.* His experiment consisted of taking three photographs of a colored object—the first one

through a *red* solution, the second through a *green* solution and the third through a *blue* solution.

From these three negatives he made three positive lantern slides, and with the aid of three magic lanterns, he projected the pictures one on the other through the red, green, and blue solutions respectively that had been used for taking the negatives. The result was that a picture in natural colors was thrown on the screen, and this was the first color photograph.

Maxwell also found that by varying the intensity of the beams of light of the lanterns and projecting them on the screen so that they would be superposed one on the other he could produce any

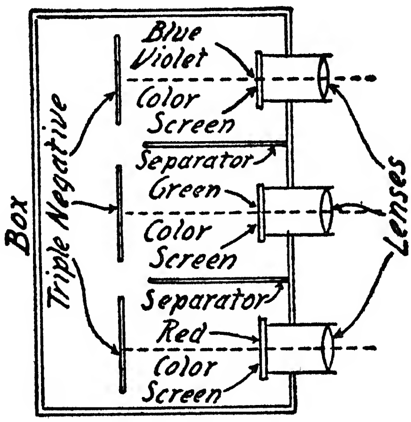


FIG. 90.—HOW THE IVES SINGLE-SHOT THREE-COLOR CAMERA IS MADE

color he wanted to and, finally, when the intensity of the beams of colored light were properly adjusted and superposed on the screen they would produce white light.

The First Practical Three-color Process.—The first practical camera and lantern for taking and projecting color photographs was invented by my late friend, Frederick E. Ives[1] of Philadelphia, in *1890*. He made a camera that was fitted with three lenses and in front of the first one he placed a *red* color filter, which was simply a disk of *red* glass, in front of the second

[1] Mr. Ives was also the inventor of the half-tone engraving process, and the three-color half-tone printing process.

one a *green* color filter, and in front of the third one a *blue* color filter, or rather a *blue-violet* glass which was found to give the best results, while back of each lens was placed a dry plate, just as it is in an ordinary camera. This is shown in *Fig. 90*.

Now when the camera was focused on an object or subject only the red rays that were reflected from it would pass through the red filter, the green rays through the green filter and the blue-violet rays through the blue-violet filter. When the exposure was made and the plates were developed and fixed all of them were simply black and white negatives, but the first one was a *color record* of the red image, the second a color record of the green image and the third a color record of the blue-violet image.

The next step was to make a glass positive of each of the negatives and these were mounted side by side on a strip of glass when a triplicate lantern slide in black and white was produced—that is, there were no colors in it but it was a *record* of the colors of the object or subject, in very much the same way that there is no sound in a phonograph record, but it is a *record* of sound.

Ives also designed and built a three-color lantern, that is, one which had three lenses in it so arranged that they could all be focused on a large screen. A single beam of light from an arc lamp or an oxyhydrogen jet provided the light for all three of the lenses, the beam being split up into three smaller beams by means of plane glass prisms and mirrors.

These beams then passed through three condensing lenses and the triplicate lantern slide that set in front of them. Finally, in front of the color-record lantern slide was placed a red, green, and blue-violet filter in the same respective positions as those were in the camera when the picture was taken. Now when the lantern slide pictures were projected on the screen the three colors blended together and the enlarged picture stood out in their natural colors. The way that the Ives three-color lantern was made is shown in *Fig. 91*.

Since the Ives three-color projection process was invented numerous schemes have been devised to make photo-color transparencies and also paper prints. Many of these have been marketed but as most of them were either too crude or too difficult to work,

especially for the novice, they gave way to processes that were more refined and which were easier to manipulate.

At the present time the chief uses of color photography are for making (*1*) transparencies, (*2*) moving-picture films, (*3*) prints, and (*4*) plates for three-color engraving processes; *color transparencies* are just as easy to make as black and white ones; color moving-picture films are easily within the scope of the novice; *color photo prints* are hard to make but you can do so if you care to take the time and trouble and, lastly, the three-color engraving process is one that requires expensive equipment and

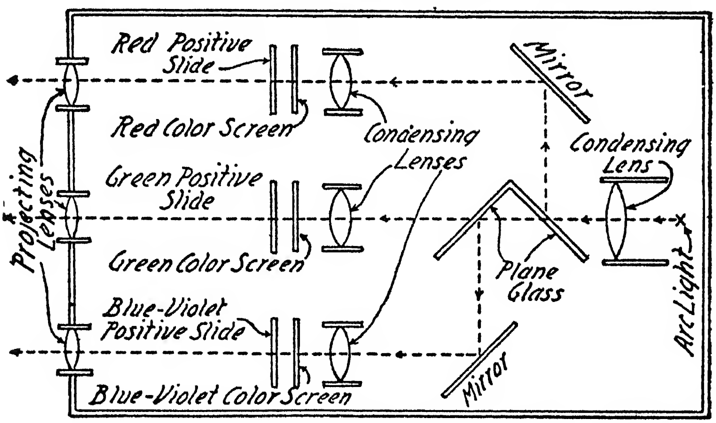


FIG. 91.—HOW THE IVES THREE-COLOR PROJECTOR IS MADE

highly skilled manipulation and, it follows, it is used only by professional photoengravers.

Present-day Three-color Processes.—There are *9* chief three-color photo-processes that are available for the amateur at the present time, *3* of them being used for making plate and film pictures, and the other *6* for making prints. Those used for making plate and film pictures are (*1*) the Finlay color process, (*2*) the Dufaycolor process, and (*3*) the Kodachrome process. Those used for making prints will be described presently.

The *Finlay* three-color process is used for making three-color transparencies, lantern slides and for commercial three-color process printing; the *Dufaycolor* process is employed for making transparencies and moving-picture films, and these can be used

for making *stills* in miniature cameras for visual observation and projection; finally the *Kodachrome* process is used for making moving-picture films and also stills.

All of the above-named processes, although quite different from each other in the way they are prepared and manipulated, are based on the Young-Helmholtz theory of color sensation and Maxwell's three-color photo experiment which I have previously described, to wit, that all of the colors in nature can be had by properly proportioning and mixing the light waves that produce the three primary colors.

The Finlay Color Process.—This process was named after Clare Finlay, of England, who devised it in 1929, and as it is the simplest one I shall describe it first. It consists of (1) a taking screen, (2) a viewing screen, and (3) a compensating filter. The *taking screen* and the *viewing screen* are practically alike and they are formed of glass plates on which are printed minute red, green, and blue-violet squares—about 90,000 to the square inch—and this is called a *mosaic* or réseau screen.

Now the way that you take a color picture is like this: You use (*a*) an ordinary camera that has a plate holder and this can be one of the usual kind, a regular Graphic or Graflex holder, a Kodak Recomar or a Zeiss single metal color-plate holder; (*b*) the taking screen, (*c*) the compensating filter and (*d*) a supersensitive panchromatic dry plate.

The *taking screen* consists of the red, green, and blue-violet squares, that are printed on it, and it is entirely separate and distinct from the dry plate. The first thing to do is to place the colored side of the taking screen and the emulsion side of the plate together and put them in the plate holder so that they will be in close contact with each other.

This done put the *compensating filter* on the lens, the purpose of this being to *even up* the rays of light that pass through the different color squares of the taking screen. Thus when you take color pictures in (*a*) the sunlight, (*b*) on cloudy days or in the shade, (*c*) by Mazda light, and (*d*) by flood-light, the difference in the color values of these various kinds of light must be compensated for and this is what the filter does.

In taking pictures with the Finlay color process a special kind

of dry plate should be used and this is known as the *Finlay-Eastman panchromatic plate*. In loading these plates into the holder you must use a green safelight and have it at a distance of at least *6* feet from it or, better, do it in absolute darkness. This done put the plate holder in the camera, focus the image without the filter on the lens, then put it on and make the exposure.

The next step is to take out the exposed plate and taking screen, and develop and fix the former in the usual way, and then make a positive of it when you will have a black and white transparency. Whatever the size of the negative, that is the size you must make the positive of it, for transparencies can only be made by this process by contact, for either enlarging or reducing them will change the size of the color squares and, it follows, they will no longer register with those on the viewing screen.

There are two ways by which you can make a transparency from a Finlay negative and these are (*a*) by making a positive on a Finlay-Ilford, a Hammer or an Eastman process plate, next placing a viewing screen on the positive, then registering it and binding them together when you will have a color transparency, and (*b*) by printing a positive on a viewing screen that is coated with a positive emulsion.

To print the positive transparency you have only to put the negative in an ordinary printing frame and lay the positive plate on it so that their emulsion coatings will be in contact with each other. To print the positive plate hold the frame at a distance of *6* feet away from a *15*-watt Mazda lamp so that it will face it squarely, then expose it for about *30* seconds.

The Finlay Trial Outfit.—To the end that you may have a chance to observe the simplicity and beauty of the Finlay process you can buy the following complete outfit and try it out for yourself. The outfit consists of (*a*) *2* taking screens, (*b*) *6* viewing screens, (*c*) *12* Finlay-Eastman panchromatic plates, (*d*) *6* Finlay-Ilford positive plates, (*e*) *1* gelatin filter, (*f*) *1* tube of developer, and (*g*) binding tape and clips.[2] The prices of the trial

[2] *Finlay Color, Ltd.*, of London, are the makers of these outfits and the *Bassani Processes, Inc.*, *305* East *45*th St., New York City, is the American agent.

outfits are as follows: (a) *3¼ x 4¼, $12.00;* (b) *4 x 5, $15.00,* and *5 x 7, $20.00.*

The Dufaycolor Process.—This process of color photography was devised by Louis Dufay, of France, in *1931,* and in its later stages of development he had the financial backing and technical assistance of *Spicers, Limited,* of London, manufacturers of paper products, and *Ilford, Limited,* also of London, makers of photo-

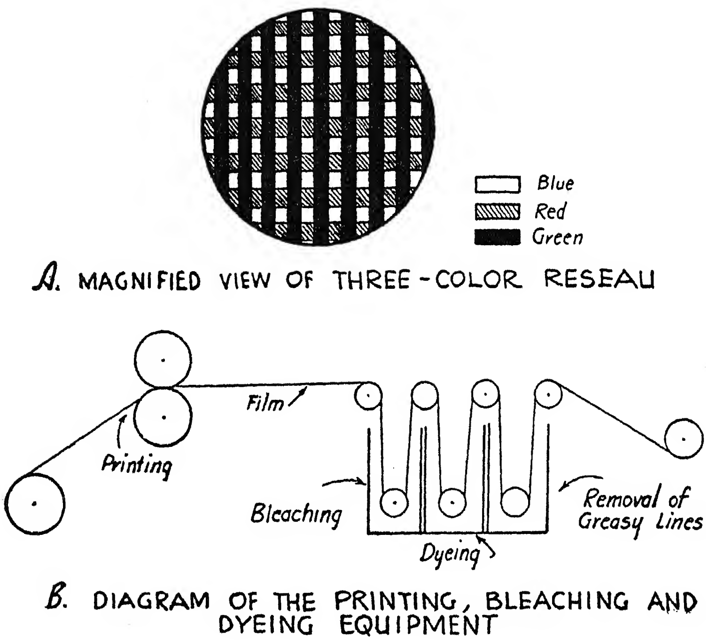


FIG. 92.—DUFAYCOLOR FILM AND HOW IT IS MADE

graphic plates and films. It is marketed in the United States by the *Defender Photo Supply Company, Incorporated,* Rochester, New York.

Dufaycolor pictures can be taken in any still or moving-picture camera, just as ordinary film is used and no extra attachments are needed. The film itself consists of the usual celluloid base and one side of it is coated with the sensitive emulsion and the other side is printed with the three primary colors, *i.e.,* red, green, and blue-violet.

The color side of the film is made by coating it with a thin layer of collodion that contains a blue dye of the correct primary color, and then by means of a precision printing-press, transverse red lines of microscopic fineness are impressed upon it. The green lines of like fineness are printed on it at right angles to the red lines; the film is then bleached so that the spaces between the red and green lines are perfectly clear and then the blue-violet lines are impressed on them, when a magnified view of it looks like *A* in *Fig. 92*, and the various processes that the film in the making goes through are shown diagrammatically at *B*.

These microscopic three-color lines produce a *mosaic screen* or *réseau* of squares which number *1,000,000*, to the square inch. A protective varnish is then applied to this screen or réseau and upon it is coated a high-speed, panchromatic fine grain emulsion when it is ready to be exposed. A filter is not needed on the lens for taking Dufaycolor pictures as the colors in the film themselves filter the light rays.

When you expose the film all of the light rays that form the image pass through the color screen first, and they then act on the sensitized coating. After the film has been exposed it must be developed and fixed, or *processed* as it is called, and this consists of *6* operations, namely, (*a*) developing the negative image, (*b*) bleaching the image to make a positive of it, (*c*) clearing the film, (*d*) re-exposing it to white light, (*e*) re-development, *i.e.*, developing the final positive image and (*f*) fixing, hardening, and washing the film. The way that these operations are performed will be explained in Chapter XX, "How to Develop and Fix Plates and Films."

Films for the Dufaycolor process can be had at the present time in *35mm.* width, *12* to *24* exposures, daylight-loading magazines for Leica and other miniature cameras, and *30* exposure daylight-loading spool for the Contax; they can also be had in *50* and *100* foot reels for *16mm.* moving-picture cameras, in most of the larger roll film sizes for hand cameras, and in standard cut sizes from *2¼ x 3¼ to 8 x 10* inches. The speed of them is about one-half of that of a panchromatic film and about one-fourth of that of a supersensitive panchromatic film.

The Kodachrome Process.—This process was devised by Leo-

pold Manners and Leo Godowsky, Jr., a couple of professional musicians, of New York City, in *1935*, and it was improved upon and brought to its present practical state by Dr. E. E. K. Mees, of the *Eastman Kodak Company*, Rochester, New York. The Kodachrome film was originally made for taking home movies in color, but it is also made at the present time for taking color *stills* with miniature cameras.

The moving-picture color films can be used with any moving picture camera that takes a *16mm*. film and has a *100*-foot capacity, and it can be thrown on the screen with any moving-picture projector of like capacity. The color films for taking *stills* can be used at snap-shot speeds either indoors with flash-lights or

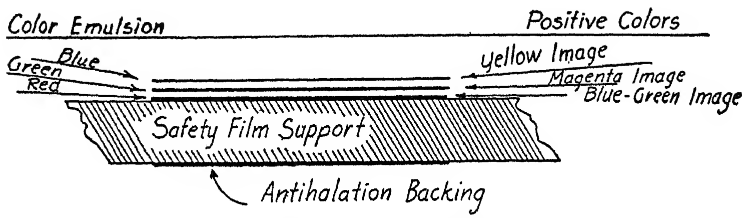


FIG. 93.—CROSS-SECTION OF KODACHROME FILM

flood-lights, or outdoors in the sunshine, and they give you color transparencies that can be viewed in their original size by transmitted light trays, or mounted in slides when they can be projected on a screen.

The Kodachrome film is formed of a celluloid strip, raw film or base, as it is variously called, and this is coated with *5* separate layers and an antihalation backing as shown diagrammatically in *Fig. 93*. The first coating is one that is sensitive to red rays; the second is a layer of gelatin that contains the blue filter dye; the third coating is the green sensitive emulsion, and on this is the fourth coating of gelatin that contains the red filter dye and, finally on this is laid the fifth coating which is formed of gelatin that contains the yellow dye. All of these coatings together are so thin that they are only a shade thicker than that of a standard film.

The development of the color image and the conversion of it from a negative to the positive requires extremely complex process-

ing and this is performed in a machine that is especially designed and built for the purpose. For this reason the processing of the films you take is done by the *Eastman Company* so that all you have to do is to make the exposures and they will do the rest for you.

Kodachrome film for miniature cameras is of two kinds and these are (*a*) for use in daylight, and (*b*) with Mazda lamps, photoflash lamps and photoflood lamps. Two sizes of color films can be had and these are the *28 x 40mm*, which cost *$1.75* for an *8* exposure roll, and the *24 x 36m'm*, which sell for *$3.50* for an *18* exposure roll. Included in the above prices is the processing, so that when you have exposed a roll of it you simply mail it to the *Eastman Kodak Company*, Rochester, New York, and when it comes back to you it is all ready for hand viewing or for mounting in slides.

How to Make Three-color Prints.—To make prints in full color is the most alluring avocation in the whole realm of photography and the most difficult one. There is no short-cut or makeshift process and while the resultant pictures that are produced with any of the processes are beautiful beyond description they are all involved to the last limits of patience. When, however, you have taken up one of the following processes the prints you make will be worth an hundred fold all of the time, labor, and what it takes that you have put into the making of them.

Now there are *6* chief processes in use at the present time by which you can make color prints, that is color pictures on paper, and these are (*1*) the Eastman Wash-off Relief process; (*2*) the Autotype Trichrome Carbro process; (*3*) the Autotype Dyebro Relief process; (*4*) the Chromotone process; (*5*) the Duxochrome process, and (*6*) the Colorstil process. Obviously it would be impossible for me to go into all the minute details of each of the above processes but full instructions can be had from the makers of the materials or of the dealers who sell them.

How to Make Three-color Separation Negatives.—To make three-color prints by any process that is in use at the present time, three separate negatives, or *separation negatives* as they are called, must be made and there are three chief ways by which this is done; these are with (*1*) a camera that is fitted

with a *sliding back,* or *repeating back* as it is also called, (*2*) a one-shot three-color camera, and (*3*) by projection with a three-color film.

The Sliding or Repeating Back.—This kind of a back can be operated much quicker, more accurately and with less trouble than where a single plate holder is used for each exposure. The back can be attached to any camera that has a ground-glass screen and which uses a plate holder. It is so made that it can be loaded with three plates and three color filters, *i.e.,* red, green, and blue-violet at one time; these latter are set in the back so that each one will slide into place in front of its particular plate as the successive exposures are made. In some makes the back is pushed over by hand, while in others it is moved along by a mechanical movement that is coupled to the cable release which works the shutter of the lens.

The One-shot Three-color Camera.[3]—A camera of this kind is quite expensive and it is used chiefly by commercial three-color process workers. It is a necessity in certain lines of three-color work as, for example, where living subjects are being photographed and short exposures must be made. One-shot three-color cameras are so made that the light which passes through the lens is split up into three beams by means of plane prisms and mirrors and form three separate images. This arrangement permits three separate plates to be exposed through their respective red, green, and blue-violet filters at the same time, and when photoflash lights are used exposures can be made in the $\frac{1}{50}$ of a second or faster.

Projection Three-color Separation Negatives.—The simplest, easiest and surest way for you to make three-color separation negatives is by projection, that is, with an enlarging lantern. The only way that this can be done, however, is by using a three-color film like the *Kodachrome* or the *Dufaycolor.* When the film with the image on it is developed it becomes a negative and by further processing, it becomes a positive as you will presently see.

To make the three-color separation negatives you have only to place the positive film in an enlarging lantern and then make

[3] One-shot three-color cameras are sold by *George Murphy, Incorporated,* 57 East 9th St., New York City.

three negatives of it of whatever size you want the picture to be. To do this you need only to use a red filter over the lens for the first one, a green filter over it for the second one, and a blue-violet filter over it for the third one. From this you will observe that you can use any kind of a camera that will take a Kodachrome or a Dufaycolor film.

How to Make Eastman Wash-off Relief Color Prints. —This is the simplest and, it follows, the easiest, of all the processes to make three-color prints. It was brought to its present state of practicability in the laboratories of Eastman Kodak Company in *1934*, and you can get the gelatin film supports, dyes, and other materials for making the prints of it or at any of its stores.

Briefly, the process consists of five chief operations, namely (*1*) making the separation negatives, (*2*) the relief positive films, (*3*) dyeing the relief films, (*4*) finishing them, and (*5*) making the transfers of them to the paper, *i.e.*, printing the latter with them. Each one of the above operations includes from four to twelve manipulations but all of them are within the ability of the novice.

The three-color separation negatives are made on panchromatic plates through Wratten filters *A*, *B* and *C5*,[4] respectively. A print is made from each one of the negatives, either by contact or enlargement on an *Eastman wash-off* relief film, and the exposures are made through the support of the relief film. This done positive silver images are developed in the relief films and these are bleached in a bichromate solution. This bleach makes the gelatin of the sensitive emulsion insoluble in the areas of the silver image.

The next step is to wash them in warm water when all of the soluble gelatin is removed and the hardened gelatin relief images are left adhering to the supports; these are fixed in the hypo solution and then thoroughly washed. Next these three relief images are dyed blue, red, and green with Eastman three-color printing dyes known as *A*, *B* and *C*. These dyed positives can now be either (*a*) superimposed so that they will be in register and thus form a three-color transparency, or (*b*) transferred on paper to make three-color prints by the *imbibition*[5] *process* as it is called.

[4] You can get these of any first-class dealer in photographic supplies.

[5] The word *imbibition* means the act or process of *imbibing*, *i.e.*, absorbing.

To transfer the dyes to paper each positive relief film is coated with its respective dye which since it is a pigment must be the complementary color of the blue, green, and red through which the negatives were made. These complementary color dyes are magenta, blue-green, and yellow. Each one of these three dyed relief films are, in turn, laid on a sheet of wet paper, that has a *mordanted*[6] gelatin coating, and then they (the films) are registered and squeegeed to print them, when a beautiful natural-color print will be made. By simply washing off the gelatin relief films, again dyeing and then printing them you can make as many more color prints as you desire.

How to Make Autotype Trichrome Carbro Prints.—This process was developed by the *Autotype Company, Limited,* 59 New Oxford St., London, England, and the agent for it in the United States is *George Murphy, Incorporated,* 57 East 9th St., New York City. It consists of making (*a*) three separation negatives of the object or subject, then (*b*) a contact or an enlarged bromide print from each of these, (*c*) preparing the celluloid support sheets, and (*d*) waxing the latter; (*e*) coating the celluloid supports with an albumen film, (*f*) sensitizing and bleaching the trichrome carbon tissues, *i.e.,* blue, red, and yellow and in this order, (*g*) mounting the color tissues on the celluloid supports, (*h*) cleaning the waxed surfaces, (*i*) immersing them in the carbro bath, (*j*) adding the colors, (*k*) transfering the prints and the color films to the final support, and, finally, (*l*) mounting the print.

The first thing to do is to make the three separation negatives, then a *matte bromide paper* is used for the prints and each one is developed and fixed separately. The celluloid support sheets are used to mount the color tissues on, but they must be *waxed* before this is done. The supports are then put in a tray that contains the albumen solution. The sheets of blue, red, and yellow trichrome carbon tissues and the three corresponding bromide prints are soaked in water.

[6] The word *mordant* means a substance that will combine with the dye to form an insoluble compound and so produce a fixed color in the fiber of the paper.

This done the tissues are put in the *carbro bath* [7] one after another at *1* minute intervals. The bromide prints are now put on sheets of glass, and the blue, red, and yellow tissues are taken out of the bath, then laid on the print and squeezed into contact with their respective prints. The bromide films with their color films on them are now put into a tray that contains an alcohol solution, and then stripped from their paper backings. Lastly the films are placed one on top of the other and carefully registered, then squeegeed together and transferred to a cardboard mount.

How to Make Autotype Dyebro Relief Prints.—This process for making three-color prints is also sponsored by the *Autotype Company, Limited,* London, and marketed in this country by *George Murphy, Incorporated,* New York City, and it consists essentially of a combination of the Autotype Trichrome Carbro and the Eastman wash-off relief processes. Briefly stated the procedure is as follows:

First a set of three-color separation negatives and three bromide prints are made in the same way as those described in the Trichrome carbro process—but with this exception—the prints or enlargements must be reversed, since they must be printed from later on. From these bromide prints three carbro images are developed on celluloid supports and this is done by the use of Autotype dyebro carbon, which is a pigment that gives only a faint gray outline as a guide for the warm-water development.

From this point on the operations are precisely the same as those employed for making Trichrome carbro prints, with the exception that the celluloid supports are not waxed. When the bromides are placed in the carbro bath the images develop easily, and after they are developed the three gelatin films, or *print plates* as they are now called, are hardened in a weak solution of formaldehyde, then washed in cold water and hung up to dry.

The procedure now changes and follows substantially the operations described above for the Eastman wash-off relief process, in that the print plates are dyed their respective colors, *i.e.,* ma-

[7] This consists of two stock solutions, *No. 1* and *No. 2.* The *No. 1* solution is formed of potassium ferricyanide, bromide, and bichromate and water, and the *No. 2* solution of glacial acetic acid, hydrochloric acid, 40 per cent formaldehyde and water. They are mixed together when they form the carbo bath.

genta, blue-green, and yellow, and this is done with *Dyebro dyes*. The plates are then registered and printed in turn on *Dyebro* pigment paper when they are mounted in the usual way.

How to Make Chromatone Prints.—This comparatively simple process of making three-color prints was devised by Francis H. Snyder and Henry W. Rimbach, of New York City, and put on the market by the *Defender Photo Supply Company*, of Rochester, New York, in *1935*. While it bears some resemblance to the dye and mordant processes previously described in that a silver positive is used as the basis from which the three-color image is formed, it differs from all of the other processes in that it consists of forming three component colored images on thin collodion stripping films.

To make a *Chromotone print* three separation negatives are used as in the other processes, and a set of three prints are produced by either contact or enlargement on Chromotone paper. All three of the prints are developed at the same time when the images are reversed and these operations must be carried on in a bromide safelight. This done the prints are fixed in the usual hypo fixing bath and then washed when the collodion emulsion image films can be easily stripped from their paper supports.

After stripping the collodion image films they are bleached and then toned in red, blue, and yellow dye solutions that are supplied with the Chromatone outfits. When they have been toned the red-image film is fixed in the standard hypo fixing bath and left in a tray of water until the other two color films are ready to be assembled. The blue-image film is now toned in the blue toning solution, then immersed in a weak hydrochloric acid solution, when it is washed and fixed in a tray of water until the other two films are ready to be assembled.

The yellow-image film is toned first in the yellow toning solution *A*, when it is put in a tray of water; it is then immersed in a standard hypo fixing bath, and washed once more, when it is toned in the yellow toning solution *B*. It is then washed again when it is ready for assembling.

To produce the finished three-color print a sheet of gelatin paper that has been soaked in water is laid on a Masonite or other like board, and the yellow-image film is laid on and

squeegeed down to the surface of the gelatin paper, which is to support the finished picture, and allowed to set for a few minutes. The red-image film is then laid on the yellow one, registered and squeegeed down to it and, lastly, the blue-image film is laid on top of the red one, registered and then squeegeed down on it when the three-color print is complete.

The final step is to let the assembled three-color film dry for a few minutes in the air; while it is yet damp the edges are trimmed even with each other and secured to a suitable mount, when the three-color print is complete.

How to Make Duxochrome Prints.—The *Duxochrome process* is sponsored by the *Ruthenberg Color Photography Company, 4961* Sunset Boul., Hollywood, California. It is like the wash-off relief process except that the films contain in addition to the sensitive silver emulsion the complementary colors mixed with the gelatin and, hence, when you have exposed, developed, fixed, washed out, and bleached them you have a color positive without the trouble of dyeing the relief yourself. There are two kinds of Duxochrome films and these are (*1*) where the gelatin is securely fixed to the celluloid base when it is used as a transparency, and (*2*) where the gelatin is stripped from the base and transferred to a sheet of paper.

To make transparencies or prints by this process the films must be exposed through the celluloid side with a safe edge mask. While the negatives may be perfectly balanced the three colored films must be given different exposures since the dyes change the density of them. To determine the time, strips of the film are enclosed in each package and these are used before the large sheets are exposed.

To develop, all the films are put in the tray and developed at the same time. The developer can be used only once, for the density of the films depends on the strength and the temperature of it (the developer). Different from developing an ordinary negative the density of the image cannot be determined by its appearance. Thus on the red and yellow films only a faint image will be seen, while on the blue film it will be almost invisible. The images will not appear until the films have been placed in the hot-water bath which will be described presently.

After the films have been developed they must be put into an acid hypo fixing bath without washing, and when they are fixed, which takes only a few minutes, the light can be turned on and the films washed until all of the free silver disappears. The next step is to immerse them in a tray of hot water, the temperature of which is about *120° F*. This will dissolve out the soluble gelatin and leave the image in relief.

The image is now formed of the gelatin which contains the dye and the silver that makes it (the image) visible. Since the silver spoils the color it must be gotten rid of and to do this the films are put into a hypo bath that has a small amount of potassium ferricyanide in it.[8] This bath will clear up the dark parts of the films and leave them transparent.

They are next washed in warm water to remove the reducer and rinsed off with cold water. Now while the three positive films are still wet they are superposed one on the other and transferred to a semi-matte or a semi-glass gelatin coated paper, when a beautiful three-color picture is the result.

[8] This is the well known *Farmer's reducer* which is described in *Chapter XIX*.

CHAPTER XVIII

HOW TO TAKE AND PROJECT MOVING PICTURES

CINEMATOGRAPH pictures, motion pictures, moving pictures, or just *movies* as they are called for short in the United States, are but different names for one and the same thing and that is miniature photographic pictures made on a long strip of film which are projected on a screen with the result that they exactly simulate the motions of the subject which was photographed. Now moving pictures are based on three chief factors and these are (*1*) instantaneous photography, (*2*) optical projection and (*3*) the persistence of vision.

About Instantaneous Photography.—As you have learned in the earlier chapters of this book there is no such factual thing as an absolutely instantaneous picture for however small the split second of the exposure may be the element of time is still there. In the diction of the photographer the term *instantaneous photography* means that the time interval of the exposure is so small when compared to the speed of the movements of the subject that the consequent picture shows the latter as though it was perfectly still when it was taken. An instantaneous picture is, then, merely a simple case of applied relativity and it is the first major factor in the making of moving pictures.

What Optical Projection Is.—The *magic lantern* is one of the earliest optical inventions and it consists of (*a*) a source of light, and (*b*) a system of lenses for projecting a very small image on a sheet of glass, or *lantern slide,* as it is called, onto a screen where a very large image is formed of it.

A *moving-picture projector* is a magic lantern that is fitted with a shutter and a mechanism so that a long strip of film can be run through it and each separate picture, or *frame* as it is called, will stop for a fraction of a second when it is immediately back of the lens. At the instant it does so the shutter opens for

the same length of time that the film remains stationary. The shutter then closes and the mechanism pulls the film on down past the lens until the next picture or frame is behind it, when the cycle of operations is repeated. The result of these coördinated movements is that a succession of the pictures or frames are projected on the screen at the rate of *16* or more per second.[1]

What Persistence of Vision Means.—The term *persistence of vision* means that when an image is formed on the retina of the eye it does not disappear the instant the rays of light that form it are cut off, but that it remains impressed on it for about an $\frac{1}{8}$ of a second. If, now, a series of separate images are formed on the retina at intervals of an $\frac{1}{8}$ of a second or less, then the persistence of vision will make them appear to be continuous. If the images are formed of a series of successive instantaneous pictures of a subject that is moving and which have been taken at intervals of an $\frac{1}{8}$ of a second or less and then projected on a screen they will produce a simulation of the moving subject that was photographed. At the present time *16* frames as the little pictures are called are projected on the screen every second for silent pictures, and *24* frames for sound pictures, as this gives a smooth continuity to the successive pictures that are seen by the eye and the sounds that are heard by the ear.

The First Successive Instantaneous Pictures.—In *1870* Eadweard Muybridge, an Englishman who was then living in San Francisco, made the first series of successive instantaneous pictures, and these were the forerunners of the moving pictures. The way in which he came to make them was like this: There had been much argument about it and about whether a horse actually had all of his feet off of the ground at any given instant when he was trotting. To determine this mooted point Muybridge set up a number of cameras spaced a little apart in a line and the shutters of each of these were operated by a thread stretched across a track.

All being in readiness a horse was then trotted down the track and as it came in front of each camera it struck the threads in

[1] In the days of silent moving pictures *16* pictures or frames were projected on the screen per second, but since the advent of sound pictures the number has been increased to *24* per second.

turn and this tripped the shutters at short intervals. In this way Muybridge was able to make a number of instantaneous pictures in succession and these showed the various positions of the horse's feet through a complete trotting stride.[2] Two years after Muybridge made these classic pictures E. J. Marcy, of England, invented a camera which would take a number of successive pictures of a moving subject on a single plate, but nothing more of importance was done toward the development of the art of moving pictures for the next *20* years or so.

The Invention of the Moving-picture Camera and Projector.—The credit for the invention of the first moving-picture camera and projector is generally given to Frieze-Green and Evans, of England, who demonstrated them in *1889*. Their camera took and projected *10* pictures or frames per second—which barely covered the time of the persistency of vision—and *300* pictures or frames could be taken with one loading.

Shortly after Frieze-Green and Evans had built their camera and projector, that is to say in *1891*, Thomas A. Edison, of Orange, New Jersey, invented a moving picture camera that he called a *kinematograph*,[3] and to keep the film from slipping he perforated it; this proved to be the keynote to the successful taking and projecting of moving-picture films and it is used at the present time.

Edison did not, however, project the moving pictures that he took but, instead, he invented an apparatus for viewing them—one person at a time—and it was used as a nickel-in-the-slot machine. He called this device a *kinetoscope*[4] and it was also introduced in *1891*. A year later my friend Jean Acme Leroy, of New York City, invented and publicly demonstrated the first real moving-picture projctor, and in *1894* C. Francis Jenkins, of Washington, D. C., likewise built and exhibited one.

In *1895* Acres and Lumière, of France, produced a moving-pic-

[2] The pictures proved that the legs of a horse move in diagonal pairs when it is in a fast trot, and also that all four of its feet are off of the ground twice during each stride.

[3] This name was compounded from the two Greek words *kinema* which means *motion* and *graphos*, meaning *to write*.

[4] This name was compounded from the two Greek words, *kinema*, which means *motion* and *scopio* meaning *to view*.

ture camera and a projector that was sufficiently practical to give public exhibitions with and this was the beginning of the moving-picture industry. It was Edison, however, who made the moving-picture camera and projector what it is to-day for he not only invented the slotted positive feed film but also the intermittent film-feed movement.

From this time on improvements were made not only in the cameras and projectors but in the films and lenses, and what with the advanced technic of the moving-picture studios the projected pictures are well-nigh perfection and the business has grown until now it is the fourth largest industry in the United States.

How the Moving-picture Camera Is Made and Works.—The moving-picture camera in its simplest form consists of (*1*) the housing or case, (*2*) the lens, (*3*) the shutter, (*4*) the gate, (*5*) a film-feeding mechanism, (*6*) a film supply reel, (*7*) a film take-up reel and (*8*) a finder. The *lens* for a home moving-picture camera should be an *f.3.5* anastigmat, and for professional cameras it often has an aperture of *f.1.5*.

The *shutter* is of the rotary disk type and has a *90*-degree segment cut out of it as shown at *A* in *Fig. 94;* it is coupled with the film-moving mechanism so that when the film stops back of the lens, the opening in the shutter lets the light rays pass through it when the exposure is made, and when it closes the film moves on. The *gate* consists of a pair of grooved ways that are secured to the back of the camera lens and the purpose of it is to keep the film flat and in the right position so that the image on it can be projected on the screen.

The *film-feeding mechanism* is formed of a *sprocket* that pulls the film continuously forward from a roll on the supply reel, and this it does by means of the sprocket teeth which fit into the perforations of the film. From the sprocket the film forms an upper loop and it then passes through the gate. The purpose of the loop is to give the film enough slack so that it can be pulled quickly down one frame at a time through the gate, and this is done by means of a claw movement that engages the perforations intermittently.

After the film has passed through the gate it forms a lower loop when it is picked up by the under teeth of the sprocket and wound

up in a roll on the take-up reel. In small cameras the mechanism is usually operated by a coiled spring, while in the larger cameras it is worked manually by a crank or by an electric motor. The way

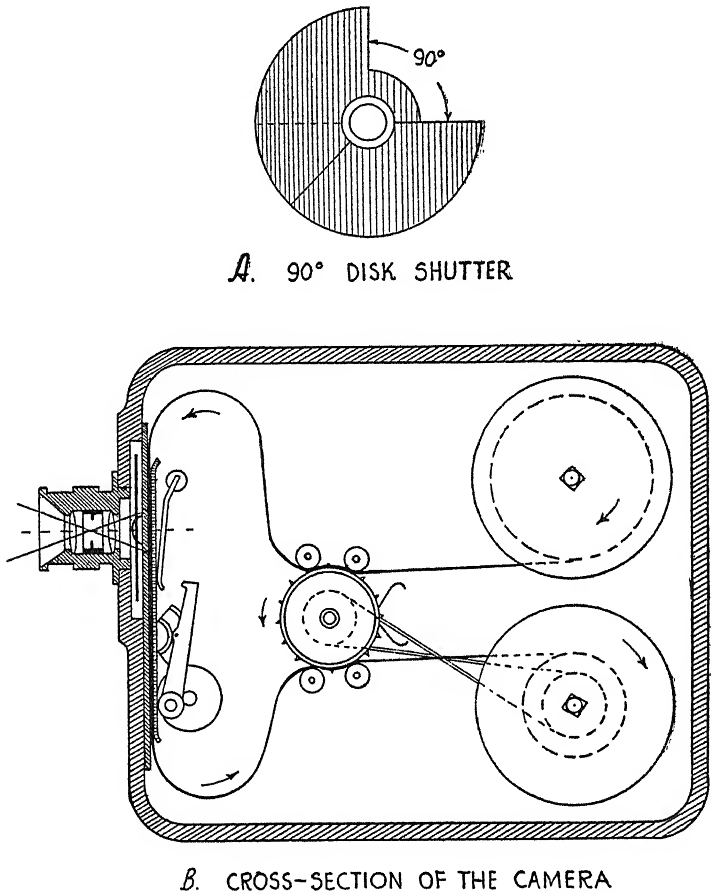


FIG. 94.—HOW THE MOVING-PICTURE CAMERA IS MADE

the camera is made and works is shown in the cross-section drawing at *B*.

Kinds of Moving-picture Cameras.—There are numerous makes of moving-picture cameras and of each of these there are usually several models. The chief makers of amateur cameras are

the *Bell and Howell Company, 1801-15* Larchmont Ave., Chicago, Illinois; the *Eastman Kodak Company,* Rochester, New York; the *RCA Manufacturing Company,* Camden, New Jersey; the *Victor Animatograph Corporation,* Davenport, Iowa; the *Ampro Corporation, 2839* N. Western Ave., Chicago, Illinois, and the *Berndt, Maurer Company,* New York City.

I can't go into the constructional details of the various cameras that these different organizations make, but inasmuch as all of them work on the same fundamental principles which I have outlined above a brief description of a few of the better-known ones will have to suffice.

The Bell and Howell Filmo Cameras.—This company makes *5* different models of amateur moving-picture cameras and which they market under the trade name of *Filmo.* The smallest one is called the *Straight 8* and, as its name indicates, it uses an *8mm.* film; it has a fixed focus *f.2.5* lens, a view-finder eyepiece, an exposure calculator, and a film footage dial which shows at a glance how many feet of film have been exposed.

Each film spool contains *30* feet of film plus ample footage for loading. To focus the camera you hold it up to your eye, and to operate it you press the operating lever down as long as you want the camera to run and then release it. Four speeds are provided, namely, *8, 16, 24* and *32* frames per second, and any one of these can be had by setting the speed control dial. The price of this little camera is *$69.00.*

The *Filmo 70-E* camera takes a *16mm.* film and makes three-color as well as black and white movies. It is fitted with a *1*-inch anastigmat *f.2.7* lens and this is interchangeable with either a wide angle or a telescopic lens. It has a spyglass view finder that gives a brilliant *upright* image which makes it easy to follow rapidly moving objects. A *critical focuser* magnifies the central area of the subject *15* diameters.

It has a *relative exposure indicator* which automatically calculates the correct diaphragm setting for any film speed after the normal exposure speed is determined. The *shutter* has an open segment of *204* degrees and this gives an exposure of $\frac{1}{28}$ of a second at normal speed, *i.e., 16* frames per second. There are four

operating speeds, namely one-half or *8*, normal or *16*, sound or *24*, and super speed or *64*.

When run at *half-speed* it accelerates sluggish action and gives double the exposure when the light is weak. *Normal speed* is used for silent films where ordinary movement and usual lighting con-

FIG. 95.—A FILMO 70-D CAMERA WITH FIXED-FOCUS, WIDE-ANGLE, AND TELESCOPE LENSES MOUNTED ON A TURRET HEAD

ditions prevail, while *super speed* gives beautiful slow-motion action studies. The speed is controlled by an accurate *governor* and with it you can instantly start and stop on any frame at any speed. Finally, it has a *100*-footage dial and a *100*-foot film capacity and the price of it ranges from *$137.00* for an *f.2.7* lens to *$186.00* for an *f.1.5* lens.

The only difference between the *70-E* camera and the *70-D*

camera is that the former has only one lens in an interchangeable lens mount and the latter has a rotatable head that is fitted with three lenses, namely (*a*) a standard, (*b*) a wide angle and (*c*) a telephoto lens. By simply turning the turret head you can instantly change from one lens to the other for quick shots. The *Filmo 70-D* is pictured in *Fig. 95,* and the prices of it range from *$102.00* to *$266.00* depending on the lenses and lens mounts that are used. All of these cameras operate by a spring that is wound up with a key and one winding will run off *23* feet of film. If you want to turn it with a hand crank you can have one fitted to the camera but this will add *$15.00* to the cost.

The Eastman Ciné-Kodak Cameras.—The Eastman Kodak Company makes six amateur moving-picture camera models and these are marketed under the trade name of *Ciné-Kodaks*. Three of these models take *8mm.* films and three of them take *16mm.* films. The *Ciné-Kodak 8 models* and all practically alike in that they are of the fixed-focus kind, have anastigmat lenses, a built-in exposure guide, an eye-level finder and an automatic footage indicator.

The *Model 20* has an *f.3.5* lens and costs *$34.50;* the *Model 25* has an *f.3.5* lens and sells for *$45.00,* while the *Model 60* has an *f.1.9* lens which is interchangeable with a telephoto lens and this is listed at *$71.50.*

The chief advantages of the *16mm.* cameras are that they take (*1*) a larger film and, it follows, the projected screen pictures are larger, (*2*) more refinements are built into them, and (*3*) the definition is better. The *Model E* camera has an anastigmat *f.3.5* lens and three film speeds—normal, intermediate, and slow-motion—*i.e., 16, 32* and *64* frames per second.

The eye-level finder shows you three things and these are (*a*) the picture you are taking, (*b*) how much of the film you are using for it, and (*c*) how much of it remains unexposed. You can use either black-and-white or Kodachrome *16mm.* films, and to thread it in the gate all you have to do is to press the latter back and slip it in. It is pictured in *Fig. 96* and costs *$48.50.*

The *Model K* camera is fitted with an *f.1.9* lens and this is interchangeable with a *15mm.* wide-angle lens which takes in a broader view coverage at close range, and a telephoto lens. It is a hand-

threading camera and takes *50* and *100*-foot films of either black-and-white or Kodachrome. It is listed at *$88.50.*

Lastly the *Magazine Model* is, as its name indicates, a camera that you can load anywhere and at any time since it does not have to be threaded. All you need to do is to slip a magazine into the camera, close the cover and you are ready to take a shot. When you want to change films you take out the magazine and slip in another one.

It has an *f.1.9* lens, which is interchangeable with seven other

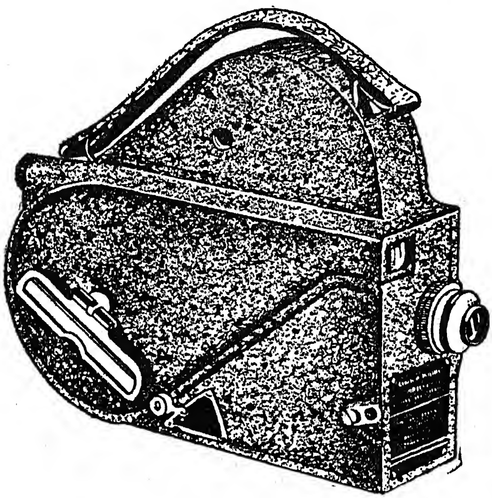


FIG. 96.—THE CINÉ-KODAK MODEL E CAMERA

lenses, and a full-vision, eye-level finder that serves for all eight lenses. It has three speeds—half-speed, normal, and slow motion, *i.e., 8, 16* and *64* frames per second. Finally, under your finger a *pulse button* keeps you informed as to the length of the scene you are shooting while your eye remains at the finder. The price of this model is *$175.00.*

The RCA 16mm. Sound Camera.—This sound-recording camera, which is the produce of the *RCA Manufacturing Co., Inc.,* Camden, New Jersey, makes moving pictures with sound accompaniment available for the amateur for the first time in the history of the art. Two units of this camera can be had and these are (*1*) the

Newsreel unit and (2) the Studio unit, and both of them use a *16mm.* film.

In the *Newsreel unit* the optical recording system is self-contained in the camera, and the operator talks into the microphone of it while he is taking the picture, while in the *Studio unit* the subject who is being photographed talks into the microphone and, it follows, his voice is recorded at the same time that his picture is being taken. The same kind of a camera is used in both of these units but in the latter one additional and exterior apparatus is employed.

The sound camera, which is shown in action in *Fig. 97,* has a fixed-focus anastigmat *f.3.5* lens, and a lens turret is secured to

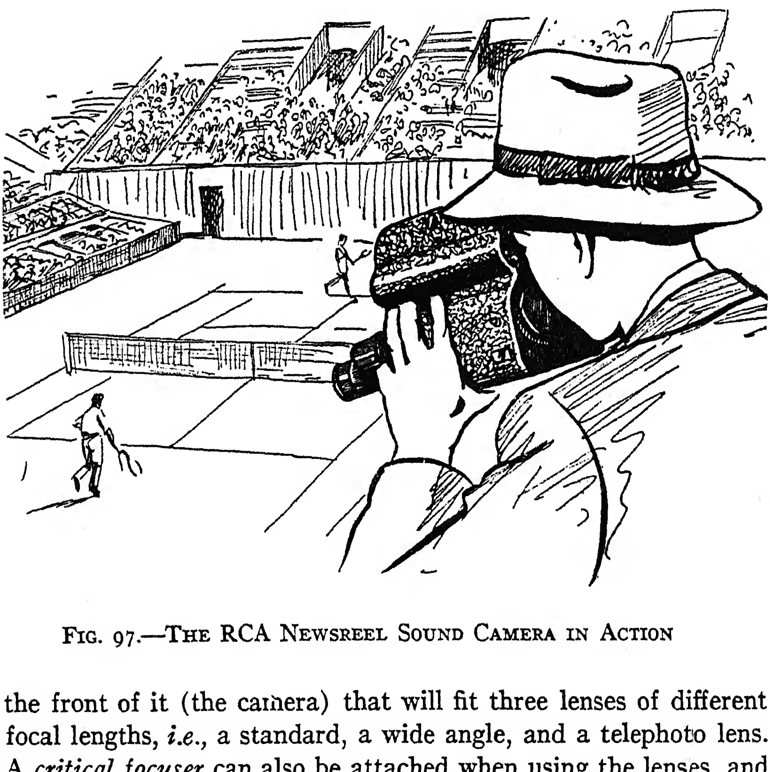


FIG. 97.—THE RCA NEWSREEL SOUND CAMERA IN ACTION

the front of it (the camera) that will fit three lenses of different focal lengths, *i.e.*, a standard, a wide angle, and a telephoto lens. A *critical focuser* can also be attached when using the lenses, and a *visual footage indicator* is provided which shows the amount of

unexposed film that still remains on the supply reel. When the reel is full it reads *100* and when it is empty it reads *0*.

Power for the operation of the camera is provided by a flat coil spring, and since it is absolutely necessary to keep the speed of the film constant for sound recording the winding gear mechanism is fitted with a device that prevents the speed of the film from falling below its correct value.

Either *24* frames per second, which is the normal speed for

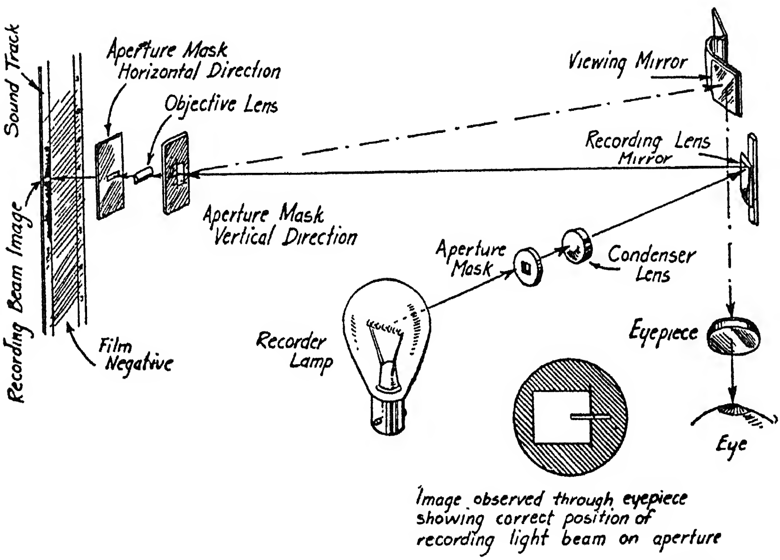


FIG. 98.—HOW THE NEWSREEL UNIT OPTICAL RECORDING SYSTEM WORKS

sound pictures, or *16* frames per second, which is the speed for taking silent pictures, can be had by simply turning the speed regulator of the camera. The film used in this camera is the *Eastman 16mm. panchromatic sound recording Kodak safety film,* and it differs from the ordinary *16mm.* film in that it has a row of sprocket holes on one margin of it only, while the other margin is used for the sound track.

The Sound Recording System.—In a system of any kind for recording sound waves on film a means is used to convert the latter into light vibrations which, in turn, make a photographic record

on the margin of it. In the *Newsreel unit optical system,* see *Fig. 98,* a beam of light from a small Mazda lamp is focused by a lens on a little mirror that is attached to the diaphragm of the microphone by means of a movable rod and lever, and this (the mirror) reflects the light beam on to the sound track of the film.

The sound waves that are set up by the voice, or other means, cause the diaphragm to vibrate and this makes the mirror move to and fro and, it follows, the beam of reflected light will swing

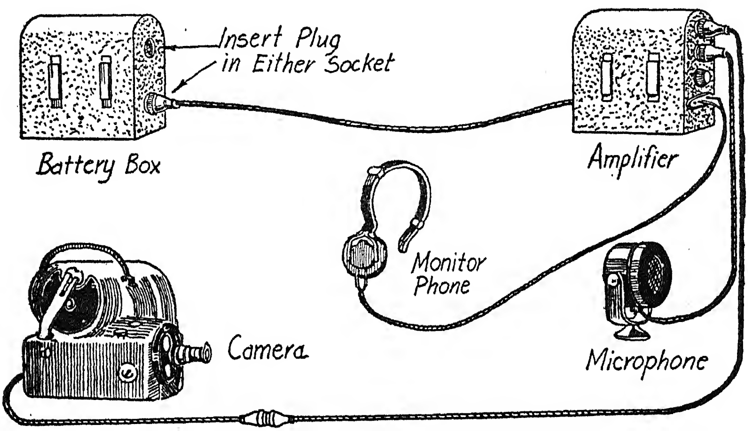


FIG. 99.—THE STUDIO UNIT RECORDING EQUIPMENT

forth and back; it then passes through the vertical opening of a mask, thence through an objective lens, and lastly through the horizontal slit in a second mask when it falls on the sound track of the film and records a photographic image on it; the diagram in *Fig. 98* shows clearly how the system works.

In the *Studio Unit optical system* the sound waves are picked up by a magnetic microphone which converts the energy of them into electric currents; the latter then flows into the amplifier unit which amplifies them several hundred times so that they are strong enough to move the coil of a reflecting galvanometer and to which the second mirror is attached. The photographic sound record is then made in the same way as with the Newsreel unit. The Studio unit recording equipment is pictured in *Fig. 99*.

About Moving-picture Films.—*Kinds of Films.*—Moving-picture films are made in three widths, and these are *35mm.*, *16mm.*, and *8mm.*, that is, *1⅜* inches, ⅝ inch, and $\frac{5}{16}$ inch, respectively, and they come in reels of varying lengths. The *35mm.* film is the standard width and it is used only for professional moving

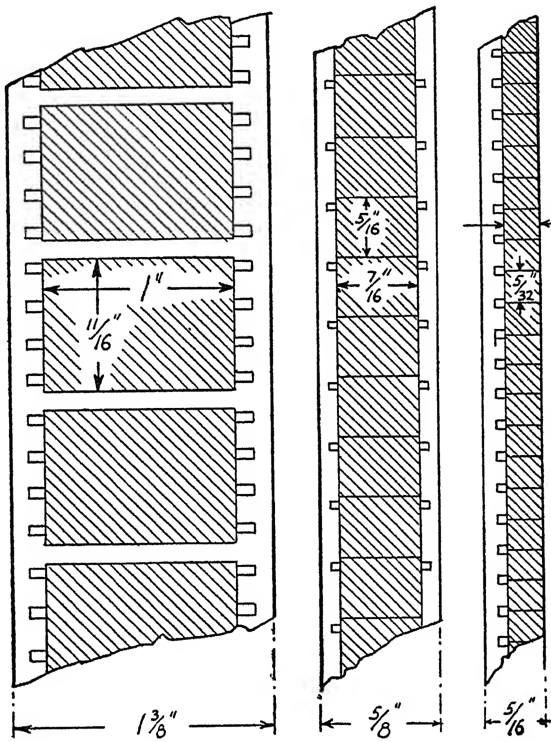


FIG. 100.—KINDS OF MOVING-PICTURE FILMS

pictures. The *16mm.* and *8mm.* films are used for amateur moving pictures and the widths of all of them are shown in *Fig. 100.*

Moving-picture films are formed of (*1*) a flexible transparent base, and (*2*) an emulsion coating which is sensitive to light. Now, as I have explained in one of the earlier chapters, there are two kinds of film base, and these are (*a*) the nitrocellulose base, and (*b*) the cellulose acetate base.

The *nitrocellulose base* is made by dissolving cotton in nitric acid when the resultant compound is called *nitrocellulose;* it is then washed in water to remove the acid and since it is very flammable and, hence, cannot be dried by heat, it is instead dried by chemical agents. After it is dry it is dissolved in amyl acetate together with some camphor when it is formed into a flexible transparent sheet. Because this kind of base is so flammable films that are made of it must be used in projectors that completely enclose it and, hence, it is employed only in professional projectors.

The *cellulose acetate base* is made by dissolving the cotton in acetic anhydride, or *acetic acid* as it is commonly called, when it is then washed, and dried; next it is dissolved in acetone together with camphor when it is formed into flexible transparent sheets. This kind of a film differs from the nitrocellulose base in that it is only slightly flammable, *i.e.,* it is about as slow-burning as if it were made of ordinary thick paper, and should it become ignited it will usually go out of and by itself. For this very valid reason it is called *Safety Film,* and it is the kind that is used for home and amateur moving-picture projection.

The base which is formed in large machines is about *3* feet wide and often *2,000* feet long, and as it is made it is wound up in rolls. It next passes through a machine that coats it with the light sensitive emulsion, and when this is dry it is cut up into strips and then passed through another machine that punches the slits in the marginal edges of it. This done the strips are rolled up and packed in light-tight containers when it is ready to be loaded into the moving-picture camera and then exposed.

The standard or *35mm.* and the *16mm.* films have slits cut in both of the margins of them, while the *8mm.* film has slits cut in only one of the margins of it. The size of the picture in each frame, or *picture area* as it is called, of a *35mm.* film is *22mm.* ($\frac{11}{16}$ *x 1* inch) and the *sound* track is *3mm.* ($\frac{1}{8}$ inch) wide. The picture area of a *16mm.* film is *7.5mm.* by *10mm.* ($\frac{5}{16}$ *x* $\frac{7}{16}$ inch), and in the *8mm.* film the picture area is *4 x 5 mm.* ($\frac{5}{32}$ *x* $\frac{3}{16}$ inch).

It follows, then, that the standard *35mm.* film has *16* pictures or frames to the foot; the *16mm.* film has *40* frames to the foot and the *8mm.* film has *60* frames to the foot. Thus when *100* feet of *35mm.* film runs through the projector at the rate of *16* frames per

second the picture lasts about one minute; when *100* feet of *16mm.* film runs through it at *16* frames per second it lasts *4* minutes, and when *100* feet of *8mm.* film runs through it at *16* pictures per second it lasts *17* minutes.

Where silent pictures are projected the standard rate of film speed is *16* frames per second, but where sound pictures are projected the speed is increased to *24* pictures per second, consequently the time of projecting them is proportionately cut down.

How the Positive Film is Made.—In the same way that a *positive* must be made of a *negative* if it is to be used as a transparency, a lantern slide, or a print, so also must a positive be made from or of the negative film before it can be projected. Now there are two ways by which this can be done, namely, by (*1*) printing a positive film from the negative in the usual way, and (*2*) converting the negative film into a positive.

Where more than one positive film is needed for projection, as for example, when they are used for theaters, by industrial concerns, for visual education, film libraries, etc., then positive prints must be made from the negative film, but where a single positive film only is required, as for home use, it is considerably cheaper to have the negative image converted into a positive image. Now while you can perform either of the above operations yourself, the simplest, surest and cheapest way is to have the positive made by a trade laboratory. Should you want to make it yourself you will find the directions for doing so in the following chapter.

About Renting Moving-picture Films.—Should you want ready-made moving-picture films to use in your projector you can rent them of the Eastman, Pathé, and other companies that operate *film libraries*. These films include such subjects as the news of the day, Micky Mouse and other animated funnies, comedies, dramas, and interesting features. These films can be used in any projector that takes a *16mm.* film.

How to Title Films.—To *title a film* means that you shoot a short length of film of the title of a subject, or of a brief description of it and then splice it into the picture film at the appropriate place. By titling your films you will greatly step up the interest in your picture stories, and not only this but editing and titling them is a hobby in itself.

Now there are several ways that you can make titles, the three chief ones of which are (*1*) to type them, (*2*) to print them and (*3*) to letter them by hand. To *type* a title you need only to slip a large card into your typewriter and type the title on it. To *print* them you must set up the line or lines in type and print them on a small *Excelsior* printing-press,[5] and to letter them by hand you must be pretty good at sign writing.

After you have made the title card you must photograph it on a strip of film and to do this you will need a piece of apparatus called a *titler* and this is shown in *Fig. 101*; this consists of a base with a frame, or *easel* as it is called, at one end and a supplementary

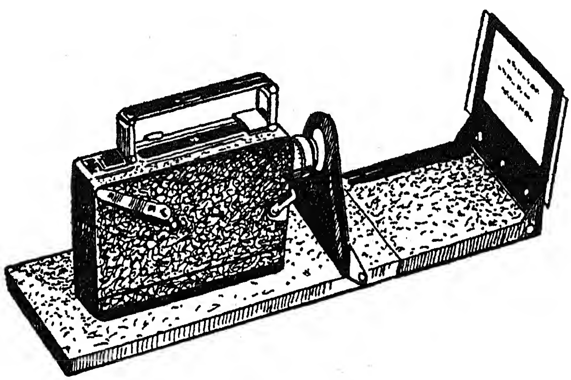


FIG. 101.—THE FILM TITLER

lens in front of it. Now set your moving-picture camera on the base with its lens in front of the supplementary lens when the lettering on the card will be sharply focused on the film. This done see that the card is properly lighted, and then expose from *15* to *25* frames to it—the number of frames will depend on the amount of reading matter there is on the card.

How to Splice Films.—After you have photographed the title or descriptive matter on the film and developed and fixed it in the usual way, the next step is to *splice it* into the scene film, and to do this easily, quickly and accurately you must have (*1*) a rewind and

[5] The *Kelsey Press Company*, of Meriden, Connecticut, make it.

(2) a splicer. The *rewind* consists of a pair of reels each of which is mounted on a spindle and these, in turn, are mounted in bearing trunnions. Each spindle is fitted with a pair of gears and a hand-crank is keyed to the driving gear of each reel.

The *splicer,* which is pictured in *Fig. 102,* is a device with which you can splice either *8mm.* or *16mm.* films. It is formed of a base on which is mounted a pair of movable clamps, a double-bladed knife and a scraper. The film that is to be spliced is laid on the base and held in place by the clamps. This done you press down on the knife which shears off both films; the ends of them are then moistened with water and the emulsion on them is removed with

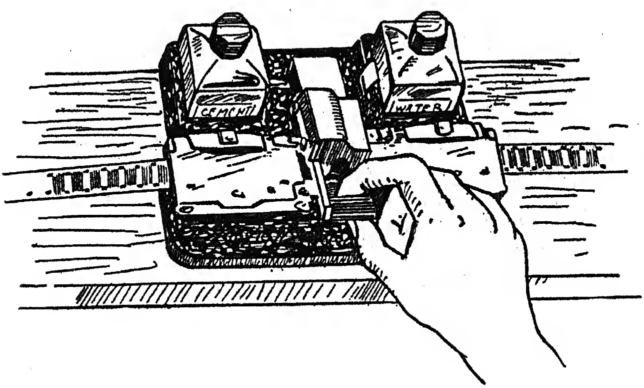


FIG. 102.—THE FILM SPLICER

the scraper. This done it is brushed over with a minute quantity of cement, and then with a slight pressure of your finger you move the film ends one over the other when they are welded together in a splice.

The Film Viewer.—If you are going to do any considerable amount of film editing then you should by all means have a *film viewer* as it will save you a lot of time and trouble. It consists of a Mazda lamp, a lens, a ground-glass screen and a notcher. They are shown in *Fig. 103.*

To use it you must have the horizontal rewind, which I described above, and set the film viewer on the base of it. Then you plug

the lamp cord into the lighting socket, next thread the film through the gate and wind it either forward or backward when you will see the frames, *i.e.*, the pictures, on the films, as brilliant magnified stills on the ground-glass screen.

When you come to the picture where you want to cut the film, and splice in a title, or a description of the scene, you press a lever

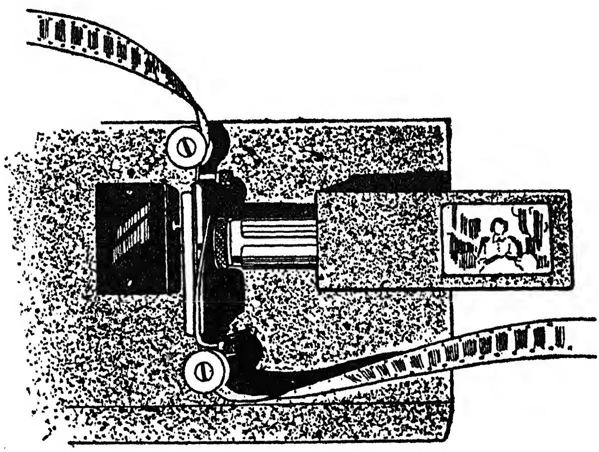


FIG. 103.—TOP VIEW OF THE FILM VIEWER

and this cuts an identifying notch on the edge of it (the film) right where the picture shows on the screen. These notches do not injure the picture or interfere with the projection of them in any way but they enable you to easily locate them by the eye or touch when you are trimming or rearranging the scenes.

How the Moving-picture Projector Is Made and Works.—In its simplest form the moving-picture projector consists of (*1*) the housing or case, (*2*) the optical system, (*3*) a rotary shutter, (*4*) a gate, (*5*) a film-feeding mechanism, (*6*) a film supply reel, (*7*) a take-up reel and (*8*) a source of light.

The optical system includes (*a*) a condensing lens, and (*b*) a projecting lens. The *condensing lens* is formed by a pair of converging lenses, while the *projecting lens* is, in the better makes, a fast anastigmat. The source of light can be either an alternating

or a direct current, and a *400* to *1,000*-watt high intensity Mazda lamp is used for home projectors while an arc lamp is used for theater projectors.

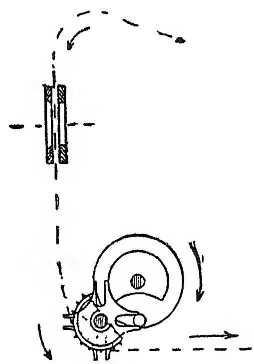
The shutter is, virtually, the same kind that I described for the camera, while the mechanism for feeding the film is made a little differently. The *film feeding machanism* is formed of a sprocket whose teeth fit in the perforations of the film and pull it continuously forward from a roll on the supply reel, and after it has passed through the gate it is moved along by the under teeth of the sprocket when it is wound in a roll on the take-up reel.

The cheapest kind of projectors are fitted with a claw movement, like the one I have previously described for the cameras, and this engages the perforations of the film and intermittently pulls it along. In the better made projectors a *Geneva* or *Maltese cross movement* is employed to pull the film along. This movement consists of a disk that has a pin fixed near its circumference. The disk rotates continuously and at every revolution the pin moves into one of the slots in the cross and carries it around until it is at right angles to its original position.

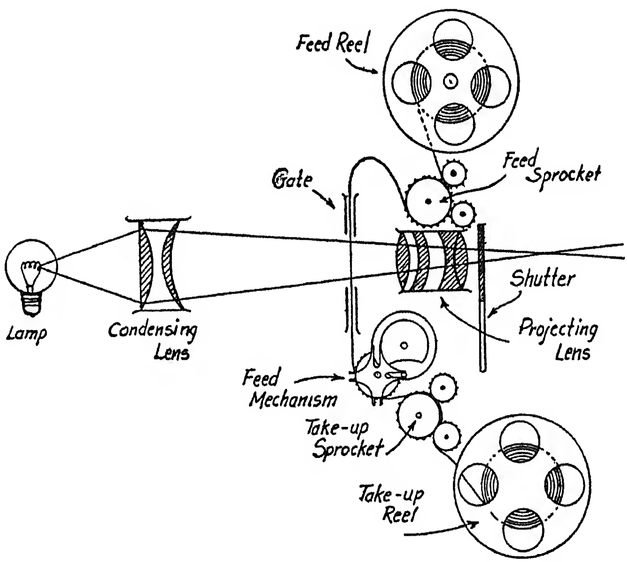
The cross is secured to a sprocket that has *16* teeth and this is moved once for each revolution of the driving wheel and, hence, it moves the film ahead *4* perforations which is the length of one frame or picture. The way the Maltese cross intermittent movement is made and works is shown at *A* in *Fig. 104*, while a diagram of the optical system and mechanical movements of the projector are pictured at *B*.

The Bell and Howell Filmo Projectors.—This company makes two kinds of amateur projectors and these are marketed under the trade name of *Filmo*. The smaller one is the *Filmo 8mm.* projector and it is fitted with an *f.1.6* projecting lens and a *400*- or *500*-watt Mazda lamp; the latter can be easily replaced even when it is hot and can be done without the use of tools or gloves.

The shutter and film registering mechanisms eliminate all vibration and, it follows, the projected pictures are perfectly steady. The films cannot get scratched as the picture area of it does not come in contact with the gate through which it runs. The tension on the edge of the film registers it at the aperture of the lens and



A. THE MALTESE CROSS INTERMITTENT MOVEMENT



B. DIAGRAM OF THE OPTICAL SYSTEM AND MECHANISM

FIG. 104.—HOW THE PROJECTOR IS MADE

the shuttle-tooth which moves straight into the perforations on the edge of the film, then pulls it down and moves straight out again. This prevents wear.

The capacity of this little projector is *200* feet of *8mm.* film and this is long enough to give a *17*-minute performance. Should you want to see a scene as a *still* on the screen you need only stop the motor. When all of the film has been run through the projector it is quickly and automatically rewound. The motor is started and stopped by simply throwing in and out a clutch. The price of the projector is *$112.50.*

The *Filmo 16mm.* projector is made in several models the largest of which is the *Auditorium Model 130,* and it is fitted with an *f.1.6* lens which has a quick, two-speed focusing mounting. It uses a *1,000*-watt *Clearay* lamp, has two separate motors—one for running the film through the projector and the other for driving the take-up spindle. It is provided with an elastic governor which can be adjusted to give operating speeds of from *16* to *24* frames per second. It also has a *variable resistance* for accurately controlling the current that feeds the lamp, and a *voltmeter* for determining the voltage of the line current.

The capacity of the projector is *1,600* feet and this is long enough to give a full one-hour show without a stop, while, of course, shorter reels can also be shown. The list price of the *Filmo Auditorium* is *$412.00.* Two other models of smaller size that are suitable for use in the home, school, church and club, and in halls and auditoriums of moderate size are made and these cost *$185.00* and *$210.00* respectively.

The Eastman Kodascope Projectors.—The Eastman Kodak Company makes *three 8mm.* and *two 16mm.* projectors. The cheapest of the former is the *Kodascope 8 Model 20* and it sells for *$39.00.* It has an *f.3.6* lens, takes *200* feet of film with one loading which is long enough to give a full quarter-of-an-hour show. The film is wound back on the supply reel by a motor rewind in a few seconds. It is fitted with a device so that you can stop the film at any frame and see the scene on the screen as a *still.* The size of the picture it projects on the screen is *36 x 42* inches. The Kodascope *8 Model 50* and *80* are better made than the *Model 20* which I have just described, and, hence they cost a little more. While they take the same size and length of film as the latter the projected pictures are larger and better.

The *Kodascope 16mm.* projectors have *f.1.6* and *f.2.5* lenses, use *400* to *750*-watt lamps and project pictures of *39 x 52* up to *54 x 72* inches and have a throw of from *11½* to *63* feet. In these projectors the threading, framing, and focusing are all very simple operations

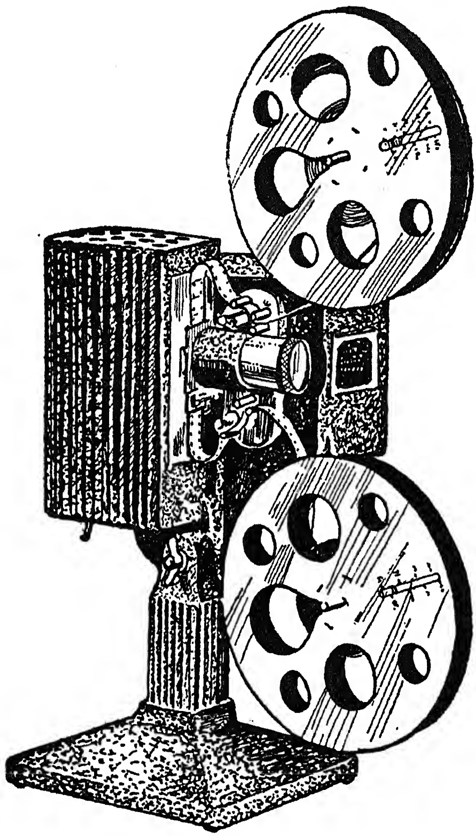


FIG. 105.—THE KODASCOPE 16MM. MODEL EE PROJECTOR

and the tandem pull-down movement provides steady pictures.

The *Model L* has a *reverse projection* device which enables you to run the film through the projector in the reverse direction so that interesting scenes and amusing screen effects can be produced. By adding extension arms *800*-foot reels can be used. The

price of the *Model EE* is *$58.45*, and of the *Model L $201.50*. The *Model EE* is pictured in *Fig. 105*.

The RCA, 16mm. Sound Projector.—To project moving pictures that have been made with a sound camera you must have (*1*) a projector and (*2*) a sound reproducer. The projector is made and works on the same general principle as those I have described for projecting silent films in so far as its optical system and mechanical movements are concerned and, hence, these need not be described again.

The Sound Reproducing System.—The sound reproducer consists of three units and these are (*1*) the sound pick-up, (*2*) the amplifier and (*3*) the speaker. The *pick-up* or *light system*, is formed of (*a*) a small Mazda exciter lamp, the light of which falls on and passes through (*b*) a vertical slit in a mask, thence through (*c*) an objective lens, and (*d*) a horizontal slit in a mask which sets in front of and close to the film; it then falls on and goes through (*e*) the sound track of the latter, which varies the intensity of the beam, when (*f*) it falls on the photoelectric cell that is placed just back of the film.

Now when the beam passes through the sound track, the lines of the latter which form the sound record varies the intensity of the beam and when it falls on the photoelectric cell the varying energy of it is converted into feeble electric currents of like varying strength. These feeble currents are then enormously increased in strength by the amplifier and these operate the loud-speaker. The way the electro-optical system is made and works is shown in the schematic diagram in *Fig. 106*.

Since the sounds are recorded on the sound track of the film it follows that the photoelectric cell will pick up the recorded impulses in perfect synchronism with the projected picture. The voltage of the reproducer lamp and the photoelectric cell are controlled simultaneously by means of a volume control.

Now the currents set up by the beam of light that falls on the photoelectric cell are exceedingly small, *i.e.*, of the order of microamperes and, it follows, that in order to make them work the speaker they must be amplified. The *amplifier unit* consists of three audio stages, and it delivers an undistorted output of *18* watts.

It gives a full-range frequency response for the new high fidelity recordings that are now made with the sound recorder.

The amplifier operates on a *100* to *125*-volt alternating *50* to *60*-cycle lighting current, or with a small converter it can be used on a direct current. The last stage of the amplifier is connected with a *12*-inch high fidelity speaker, and this is so designed and made

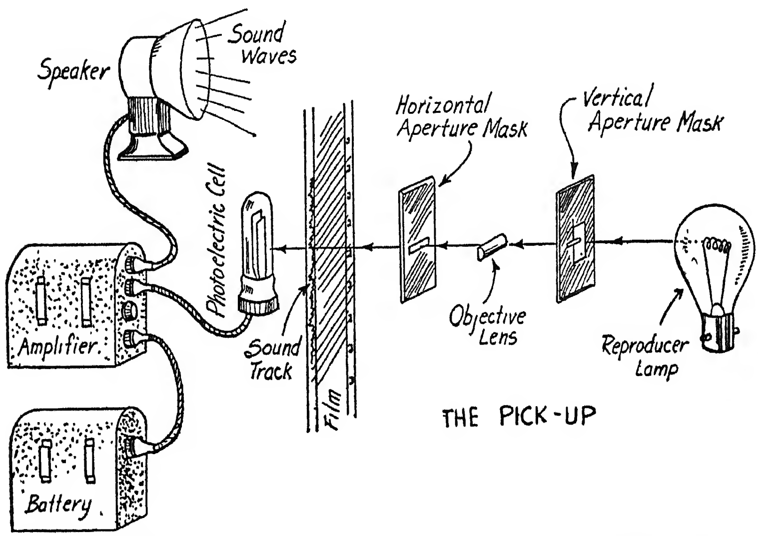


FIG. 106.—HOW THE ELECTRO-OPTICAL SOUND REPRODUCER SYSTEM WORKS

that it will deliver a maximum response over the whole audible frequency range. The RCA *PG-71* Portable Sound Projector is shown in *Fig. 107*, and the price of it is *$550*.

The Bell and Howell Co., makes three models of *16mm.* sound moving-picture projectors which they market under the trade name of *Filmsound*. The first of these is *Model 138* and it has a *750*-watt Mazda lamp. It is compact and portable and is suitable for home entertainment, school class-rooms, show-rooms, small halls, etc. It is fitted with a *12*-inch speaker, but by using a *booster amplifier* the volume of sound can be so increased that it will serve an audience of *1,000* or more. It has a film capacity of *1,600* feet, and it sells for *$450*.

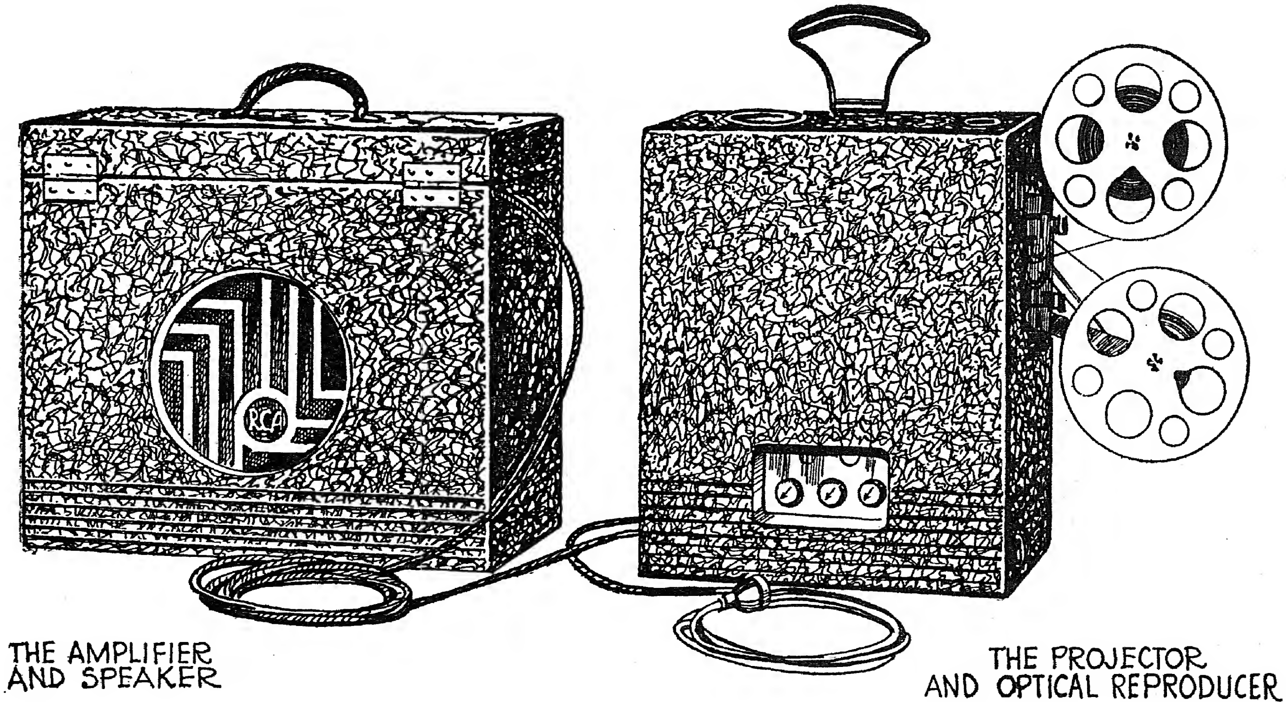


FIG. 107.—THE RCA PORTABLE SOUND PROJECTOR

The *Model 120* likewise uses a 750-watt lamp, and while it is a portable projector it is large enough for an audience of 1,500 or more. It has a film capacity of 1,600 feet and this will give an uninterrupted program that runs for 45 minutes. The list price of it is $630. Finally, *Model 130* uses a 1,000-watt lamp and is of the semi-permanent type of sound moving-picture projector. It provides a maximum screen illumination and sound volume for an auditorium that has a capacity of 2,500. It is housed in two carrying cases, and the price of it is $875.

CHAPTER XIX

DEVELOPING AND FIXING AGENTS

IN ONE of the earlier chapters I explained that after the latent image has been formed on the plate or film by exposing it in the camera it must be brought out so that it can be seen, or *developed* as it is called, and then to prevent the light rays from further acting on it, it must be *fixed*. Now before we get into the actual operations of developing and fixing plates and films let's find out about the various chemicals that are used for these purposes and how they are combined to make developing and fixing solutions.

What a Developer Consists of.—What we call a *developer* is a compound that has an affinity[1] for oxygen (*O*) as it is this gas which combines with the bromine (*Br*) in the emulsion on the plate or film after it has been separated out from the metallic silver (*Ag*) by the light rays. Now while there are many oxygen compounds there are only a few that can be used for developers because nearly all of them will not only combine with the bromine after it is separated out from the silver but they also combine with it while it is associated with the silver in the form of silver bromide (*AgBr*). A developer usually consists of five different compounds and these are (*1*) a developing agent, (*2*) an accelerator, (*3*) a preservative, (*4*) a restrainer, and (*5*) water.

A *developing agent*, of which there are several kinds, cannot of and by itself bring out the latent image to any great extent, but an *accelerator* must be added to it in order to make it active. An alkali, such as sodium carbonate, is generally used for this purpose, but when a developing agent and an alkali are dissolved in water the oxidation is so rapid that the plate or film which is being developed will be stained.

[1] The word *affinity* in chemistry means the attractive force exerted in different degrees *between atoms* which makes them combine with each other *and remain so*.

To prevent this untoward action a *preservative* must be added and this can be sodium sulphite; what it does is to bleach out the stain produced by the oxidation of the developing agent and the alkali when the developer will remain clear. Finally a *restrainer* is added to the developer since the tendency of the developing agent and the accelerator is to fog the emulsion and so spoil the image. The bromides and iodides of sodium and potassium are usually employed for this purpose.

Kinds of Developing Agents.—For the reason cited in the first paragraph there are very few compounds that can be used as *developing agents*, the chief ones of which are (*1*) pyrogallol, pyrogallic acid, or just *pyro* as it is called for short, (*2*) hydroquinone, (*3*) one of the several amino-phenols, (*4*) amino-napthol-sulphuric acid, and (*5*) para-hydroxy-phenol glycin, or just *glycin* as it is called for short.

When the *amino-phenol* developing agents are combined with the other necessary agents to form a developer they are sold under such trade names as *Metol, Rhodinal, Amidol, Kodelon,* and *Elon;* that made with amino-napthol-sulphuric acid is called *Eikonogen;* while that formed with para-hydroxy-phenol glycin is known as *Glycin.*

And now before we use them to make developers let's take a look at the nature of them and find out how they are made and what they are made of. Pyrogallic acid ($C_6H_3(OH)_3$) is a poisonous, white crystalline compound that is made from *gallnuts,* and these, in turn, are swellings that are formed by certain parasites. The gallnuts are fermented when gallic acid ($C_6H_2(OH)_3.CO_2H$) is produced; this compound is then heated in a still when it becomes pyrogallic acid, and it is also produced synthetically. It comes in two forms and these are (*a*) a flaky powder, the trade name of which is *Resublimed Pyro,* and (*b*) crystals; this latter is generally used for making a developer as it is more easily handled.

Hydroquinone ($C_6H_4(OH)_2$) is also a white, crystalline compound, and it is usually obtained by the reduction of quinone ($C_6H_4O_2$); this latter compound is, in turn, made by the oxidation of quinic acid ($C_6H_4(OH)_4$ CO_2H), aniline and other compounds. While hydroquinone is not as strong a developer as pyro it is better in that it does not stain the negative as easily as the latter.

It is often used with *Elon* as they neutralize each other in respect to speed and density; thus when hydroquinone is used the image slowly appears while the density of it gradually and quickly takes place. Oppositely, with *Elon* the image quickly appears while the density of it slowly takes place. Again a slight change in the temperature of a hydroquinone developer greatly affects it, while it scarcely has any effect on an *Elon* developer. It follows, then, that by combining them a better balanced developer results.

Amino-phenol ($C_6H_4(NH_2)OH$) is a compound that is formed by combining amino acid (NH_2) with phenol (C_6H_5OH) or *carbolic acid* as it is commonly called. It is not a very stable compound and as it easily oxidizes it is used in combination with various other compounds as a developer. Chief among these are para-amino-phenol (p-$C_6H_4(NH_2)OH$) which is sold under the trade name of *Rhodinal;* dia-amino-phenol (d-$C_6H_4(NH_2)OH$), which is a very similar compound, is sold under the trade name of *Amidol,* and the N-methyl derivative of p-amino-phenol ($CH_3NHC_6H_4OH$) is largely used as a developer and this is the well known *Metol.*

Para-amino-phenol oxalate (p-$C_6H_4(NH_2)OH.C_2H_2O_4$) is, as its formula shows, obtained by combining para-amino-phenol with oxalic acid, and it is sold as a developer under the trade name of *Kodelon.* Mono-methyl para-amino-phenol sulphate (C_6H_4-$(NH_2)OH.H_2SO_4$) is made by combining methyl (CH_3) and para-amino phenol ($C_6H_4(NH_2)OH$) with sulphuric acid (H_2SO_4). It differs from para-amino-phenol sulphate in that it is soluble in its own weight of hydrochloric acid whereas the latter is insoluble. It is marketed as a developer under the well known trade name of *Elon.*

A-Naphthol ($C_{10}H_7OH$) can be obtained by fusing naphthelene-a-sulphonic acid with caustic soda, and by other processes. Amino-naphthol-sulphonic acid ($NH_2C_{10}H_7(OH)(SO_3H)_6$) is largely used as a developing agent under the trade name of *Eikonogen.*

Lastly para-hydroxy[2]-phenyl[3]-glycin ($C_6H_5(OH)CH_2NH_2$-

[2] *Hydroxy* is a combining form of *hydroxyl;* it is the radical OH which means that it consists of 1 atom of hydrogen and 1 atom of oxygen.

[3] *Phenyl* is the radical C_6H_5 which means that it consists of 6 atoms of carbon and 5 atoms of hydrogen.

CO_2H) is formed by the combination of para-amino-phenol and mono-chlor-acetic acid. It does not dissolve easily in water but does so readily in a weak alkaline solution. It is sold under the trade name of *Athenon,* and is largely used for making a developer that gives warm tones to chloro-bromide papers.

Kinds of Accelerating Agents.—Sodium hydroxide ($NaOH$) or *caustic soda* as it is commonly called, and potassium hydroxide (KOH), or *caustic potash,* are sometimes used as accelerators, as they give with hydroquinone a warm tone for lantern and process plates, but they must be used in very diluted state or they are apt to cause frilling.

For standard developers milder accelerators are used and chief among these are (*1*) sodium carbonate (*soda*), (*2*) potassium carbonate (*potash*) and (*3*) sodium tetraborate (*borax*). There are three forms of sodium carbonate (Na_2CO_3) and these are (*a*) the crystal, (*b*) the desiccated, and (*c*) the anhydrous or dry form. The *crystal form* ($Na_2CO_3.lOH_2O$) contains, as its formula shows, a high percentage of water; the *desiccated* or anhydrous [4] form ($Na_2CO_3.H_2O$) contains a very small percentage of water, while the anhydrous or dry form ($NaCO_3$) is the kind that is usually employed for making developers.

Potassium carbonate ($K_2CO_3.3H_2O$) is a white salt that is obtained from wood ashes, potassium sulphate, etc., and when dissolved in water it forms a strong alkaline solution. It is sometimes used instead of sodium carbonate as an accelerator, but it is much more active than the latter and, hence, has a greater tendency to produce stain and frilling. Another untoward feature of it is that it has a great affinity for water and, further, it costs a little more. For these reasons sodium carbonate is used in all ordinary developers as an accelerator.

The chief borate is sodium tetraborate ($Na_2B_4O_7$) and this is found in a nearly pure state in Death Valley, California. It is used as an accelerator in developers for (*a*) obtaining fine-grain negatives, and (*b*) to increase or decrease the time of development with or without affecting the contrast. Since it is not as strongly

[4] *Desiccated* and *anhydrous* both mean *dry,* and it is dry when compared with the crystal form, but not when compared with the anhydrous form.

alkaline as sodium or potassium carbonate it is used where a less active accelerator is required as with a metol-hydroquinone developer. When it is used with the latter it produces warm-black tones.

Kinds of Preservative Agents.—As I have previously mentioned the developer that now contains a developing agent and an accelerator must have a preservative to prevent the oxidation from being too rapid, in which case it will stain the plate, film or paper. Now the chief preservative that is used is (*a*) sodium sulphite ($NaSO_3.7H_2O$), (*b*) sodium bisulphite ($2NaHSO_2$), and (*c*) sodium meta-bisulphite (NaS_2O_5).

Sodium sulphite is obtained by forcing sulphur dioxide gas into a concentrated solution of sodium carbonate, and when the latter has been saturated with it an equal volume of sodium carbonate which has the same strength is added to it. When the solution is cold, white, waxy-looking crystals that contain 7 parts of water are formed by it.

Sodium bisulphite is formed when sodium sulphite combines with sulphurous acid, and *sodium meta-bisulphite* is obtained by combining sodium sulphite with sulphur dioxide. All of the above sodium sulphites not only act as preservatives for developers but they serve to energize those that contain *amidol* as the developing agent. They also have a solvent action on silver bromide and when an excess amount of any one of them is used in a developer it tends to produce fog and to restrain development.

Potassium meta-bisulphite ($K_2S_2O_5$) is sometimes used instead of the sodium sulphites as a preservative for developers, especially where pyro or hydroquinone is used as the developing agent. It comes in the form of small, white, transparent needle crystals, and these must be dissolved in cold water for hot water will decompose them. There is no particular advantage in using it instead of sodium sulphite as it costs considerably more and the latter is just as satisfactory.

Kinds of Restraining Agents.—The *fog* that is produced by the developing agent and accelerator in a plate or film consists of a condensation of fine particles of metallic silver in them, and the purpose of a restrainer is, of course, to prevent it. The chief re-

straining compound is potassium bromide (KBr) and it is made by the direct combination of nonmetal bromine, which is a liquid, and potassium, a metal.

Potassium bromide comes in two forms, *i.e.*, as (*a*) a coarse, white powder, and (*b*) colorless crystals. It is easily soluble and stable either in the crystalline state or when it is in solution. Its restraining action varies greatly according to the kind of developer that is used; thus it has but small effect when it is used with a metol developer but it acts quite vigorously when it is used with either a pyro or a hydroquinone developer.

The exact chemical reaction of potassium bromide as a restrainer is not with certainty known but it is assumed to be caused by the absorption of it by the silver bromide grains and this prevents the developing agent from reducing them so easily. Potassium iodide (KI), sodium iodide ($NaNO_2$) and sodium bromide ($NaBr$) can all be used as restrainers in developers, but owing to their deliquescent nature, *i.e.*, their great affinity for water, potassium bromide is preferred.

Finally, water (H_2O) is, of course, the solvent that is used for dissolving the other compounds in making up developers. Since it is neither an acid, a base nor a salt it reacts very little, or not at all with the constituent compounds of a developer and, it follows, it is the ideal solvent for this purpose.

Pure water is a necessity in making up developers and distilled water is the best for this purpose. If it is not to be had then mix the developing agents with warm water (about 125° F.) and let it stand overnight when any suspended matter in it will be precipitated and the clear developer can then be poured off.

Kinds of Developers.—As you have seen from what has gone before there are numerous kinds of developers and the following formulas are some of the standard ones.

Formula for a Manual Pyro Developer

The following pyro developer, which is due to Welborne Piper, of England, is one of the best in that the stock solutions keep well and do not stain the negatives. It is best suited for the manual development of plates and cut films:

Stock Solution A

Pyro	1 oz.
Sodium sulphite (anhydrous)*..........	4 oz.
Potassium meta-bisulphite	1 oz.
Water	60 oz.

* Or 8 ozs. of it in crystal form.

Stock Solution B

Sodium carbonate (anhydrous)**	4½ oz.
Water	60 oz.

** Or 12 ozs. of it in crystal form.

The Developer.—At the time you want to use it mix 1 part of *Stock Solution A* and *Stock Solution B* and add 2 parts of water.

Following is a formula suitable for the automatic development, *i.e.*, by the time and temperature method, of roll and cut films. You must make it up fresh at the time you use it:

FORMULA FOR A PYRO AUTOMATIC DEVELOPER

Sodium sulphite (anhydrous)........	40 grains
Sodium carbonate (anhydrous)	40 grains
Pyro	15 grains
Water to make.....................	20 ounces

Temperature in degrees Fahrenheit	68	64.4	60.8	57.2	53.6	50
Time of development in minutes...	17	20	24	28	32	36

FORMULA FOR A ONE-SOLUTION METOL-HYDROQUINONE DEVELOPER

Hot Water (about 125° F.)	8 ounces
Metol	56 grains
Sodium sulphite (anhydrous)	1½ ounces
Hydroquinone	85 grains
Sodium carbonate (anhydrous)	280 grain
Water to make	32 ounces

Dissolve the compounds in the order given in the above formula. At the time you want to use it add an equal amount of water to it.

Formula for a Two-Solution Metol-Hydroquinone Developer

Stock Solution A

Hot Water (about 125° F.)	8 ounces
Metol	64 grains
Sodium sulphite (anhydrous)	96 grains
Hydroquinone	80 grains
Potassium bromide	24 grains
Water to make	32 ounces

Stock Solution B

Sodium carbonate (anhydrous)	180 grains
Water	32 ounces

In cold weather the amount of metol should be increased to *90* grains and the hydroquinone decreased to *48* grains. At the time you want to use it mix equal parts of the *Solutions A* and *B* together.

Formula for a Metol-Hydroquinone Automatic Developer

(*For Rapid Tank Development*)

Metol	11 grains
Sodium sulphite (anhydrous)........	1½ ounces
Hydroquinone	33 grains
Sodium carbonate (anhydrous)	½ ounce
Potassium bromide (10% solution) ..	2½ drachms
Water to make	20 ounces

Develop for *5* minutes at *65°* F.

Formula for an Amidol Developer

(*For Manual or Tank Development*)

Sodium sulphite (anhydrous)........	1½ ounces
Potassium bromide	16 grains
Amidol (diaminophenol)	80 grains
Water to make	32 ounces

Dissolve the first two compounds in the water, and then add the amidol. This developer should be made up fresh as it will not keep longer than three days.

FORMULA FOR A GLYCIN DEVELOPER

(For Slow Tank Development)

Sodium sulphate (anhydrous)	130 grains
Glycin	90 grains
Potassium carbonate (anhydrous)....	400 grains
Water to make	20 ounces

When you want to use it mix *1* part of this solution with *5* parts of water.

This fine grain developer which is due to A. and L. Lumière and A. Seyewetz, goes by the trade name of *Micros:*

FORMULA FOR A FINE GRAIN DEVELOPER

Metol	22 grains
Sodium sulphite (anhydrous)	262 grains
Hydroquinone	7 grains
Para-phenylene-diamine (base)	44 grains
Trisodic phosphate	17 grains
Potassium bromide	4½ grains
Water to make	10 ounces

Develop for about *7* minutes at *65°* F.

The makers of plates and films have their own formulas for developers and it is a good scheme to use those that they recommend. You will find, however, that they do not deviate very much from those I have given above.

Fixing the Developed Image.—To prevent the developed image from being further acted upon when it is brought out into the light the silver bromide that has not been decomposed by the rays and, hence, has not been attacked by the developer, must be removed from the sensitized gelatin coating. To do this it must be immersed in a *fixing bath,* that is, one which will dissolve out the silver bromide that has not been acted on by the rays.

Now a *fixing bath* usually consists of five different compounds and these are (*1*) the fixing agent, (*2*) a stain preventive, (*3*) a preservative, (*4*) a hardener, and (*5*) water.

The Fixing Agent.—The chief compound that has been used as a fixing agent ever since it was discovered by Herschel is sodium

thiosulphite ($Na_2S_2O_3.5H_2O$), or *hyposulphite of soda,* as the photographers call it, or just *hypo* for short. Sodium thiosulphite, or hypo, is made by boiling sodium sulphite and sulphur together when they combine and form large clear crystals.

Now when a plate, film, or paper that has been developed, is immersed in a solution of hypo and water, the silver bromide combines with the former and makes complex compounds of silver and bromide thiosulphates.

Although hypo is the only compound that is necessary to dissolve out the silver bromide, or *fix* the negative, as it is called, and while the plate, film, or paper is washed after it is developed, particles of the developer still remain in the gelatin; these are soaked out in the fixing bath and oxidized, with the result that it soon becomes discolored and stains the negative or print.

The Stain Preventive Agent.—To prevent this untoward action from taking place an acid is added to the bath. Now while the fixing bath must contain a large amount of acid to make it effective, it must be only weakly acid, and to fulfil these two opposed conditions acetic acid (CH_3COOH) is used.

Acetic acid was formerly obtained by the oxidation of vinegar, but is now produced by the destructive distillation of wood and synthetically by the oxidation of alcohol or acetylene. In its pure state it is a colorless, pungent, biting liquid that congeals at comparatively low temperatures, hence, it is called *glacial acetic acid,* and this contains *95.5* per cent of the acid. When the acid is added to the fixing bath it neutralizes whatever alkali of the developer that may be left over in the gelatin coating, and this prevents it from staining. To give a fixing bath the proper strength *3* parts of glacial acetic acid should be dissolved in *8* parts of water.

The Preservative Agent.—The way that sodium sulphite ($NaSO_3$) is made and the different forms of it have been previously described. Now when an acid is added to a fixing bath it decomposes the hypo and sets the sulphur in it free, and by adding sodium sulphite to the bath it combines with the sulphur and forms hypo. Dessicated sodium sulphite is the kind that is used as a preservative.

The Hardening Agent.—When a plate, film or paper is immersed in a fixing bath the gelatin coating absorbs the water and gets

soft when it swells up and frills. To prevent it from doing so a hardening compound must be added to the fixing bath. Now there are two chief kinds of compounds that are used for hardening the gelatin coating and these are (*1*) alum and (*2*) formalin.

The two principal kinds of alum that are used for hardening are (*a*) chrome alum and (*b*) potash alum. Chrome alum (K_2SO_4, $Cr_2 (SO_4)_3.24H_2O$) is formed by combining potassium sulphate with chromium sulphate when dark violet crystals are produced. When it is dissolved in cold water it takes on a violet hue and if it is heated it becomes green. It is largely used for hardening fixing baths for plates and films.

Potash alum ($K_2SO_4, Al_2(SO_4)_3.24H_2O$) is formed of potassium sulphate and aluminate sulphate when translucent colorless crystals are produced. It is soluble in hot water and is used chiefly for hardening fixing baths for sepia toned prints. Both of the above alums are formed of large clear crystals but these are reduced to very small crystals so that they can be the more easily weighed out. They are better than powdered alum as they do not form lumps.

Formalin is a *40* per cent solution of formaldehyde ($HCHO$), formic aldehyde, or formic anhydride as it is also called, and water. It is a gas that has a strong, pungent odor and an irritating effect on the eyes, nose, and throat. It is readily absorbed by water and a solution of it forms a very active hardening agent for gelatin. A solution of *1* part of commercial formalin to *20* parts of water is amply strong enough for fixing baths.

How Sludging Is Prevented.—The acidity of a fixing bath is limited in range as far as its hardening properties are concerned, and to extend it and decrease the tendency of it to *sludge*, that is, to throw down a slimy sediment, boric acid ($B(OH)_3$) is often added to it. This compound is obtained by adding sulphuric or hydrochloric acid to a solution made of boric oxide dissolved in hot water. It is then allowed to cool when white crystals of boric acid will separate out from it and these are purified by recrystallization.

Kinds of Fixers.—There are two chief kinds of *fixing solutions*, or *fixers*, as they are called, and these are (*1*) acid fixers and

(2) alum fixers. There are several kinds of *acid fixers* but the following is a standard one:

FORMULA FOR AN ACID FIXER

Sodium thiosulphite (crystals)	4 to 6 ounces
Sodium sulphite (anhydrous)	45 grains
Acetic acid (glacial)*	50 minims
Water to make	20 ounces

* You must be careful not to let the concentrated acetic acid solution touch your skin as it is a powerful caustic.

Dissolve the sodium sulphite in *3½* ounces of cold water, then dilute the acetic acid with *50* minims of water, add it slowly to the sodium sulphite solution and stir it constantly while you are doing so. Dissolve the hypo in the water and add the above solution to it a little at a time.

FORMULA FOR AN ALUM FIXER

Sodium thiosulphite (crystals)	5 to 6 ounces
Hardening solution (see below)	1 ounce

HARDENING SOLUTION

Common alum	2¼ ounces
Acetic acid (glacial)	2 ounces
Sodium sulphite (anhydrous)	525 grains
Water to make	20 ounces

Dissolve the alum in *12* ounces of water and the sulphite in *4* ounces of warm water. The acid is poured into the alum solution and well mixed and, finally, the sulphite solution is added to the latter and enough water is poured into it to make *20* fluid ounces.

About Reducers and Intensifiers.—*Kinds of Reducers.*—As I mentioned under the caption of *Developers* the process of getting rid of the bromine from the silver after the light has decomposed the silver bromide by means of a developer is called *reduction.* Now a different kind of reduction, and this must not be confused with development reduction, is to convert a dense negative, or one that is too contrasty, into a thinner one, and this is done after it is developed by removing some of the silver there is

in it. A negative of this kind is caused by either (*1*) overexposure or (*2*) overdevelopment.

Now all photographic reducers depend for their action on oxidizing the silver of the negative, that is, they contain oxygen and this combines with the silver when silver oxide is formed which can be washed out of it. There are three chief kinds of reducers and these act quite differently one from the other on the high-lights and shadows of the image. These reducers are called (*1*) subtractive or cutting reducers, (*2*) proportional or true-scale reducers, and (*3*) super-proportional reducers.

A *subtractive* or *cutting reducer* is used to thin out overexposed negatives and this it does by removing the same amount of silver from all parts of the image, and, it follows, that the proportion of silver which is removed from the shadows will be greater than that which is removed from the high-lights of the negative.

Farmer's reducer is a well-known one of this kind and it is made by adding some potassium ferrocyanide ($K_4Fe(CN)_6$) to the fixing bath. Now when the overexposed negative is immersed in the bath the oxygen of the ferricyanide combines with the particles of silver and forms silver-ferricyanide; this latter compound is dissolved by the hypo when it is washed out with running water.

A *proportional reducer* is one that reacts on the silver of a negative just the opposite of that of a developer, *i.e.*, while a developer increases the density of all the parts of a negative in exactly the same proportion, a reducer decreases the density of all parts of it in the same proportion. Since this is the way of it where a negative has been correctly exposed, and the density is caused by its being overdeveloped, it should be reduced with a proportional reducer. To make a reducer of this kind potassium permanganate ($KMnO_4$), which is a mildly subtractive reducer, is combined with ammonium persulphate ($(NH_4)_2S_2O_8$), which is a super-proportional reducer, when a proportional reducer results.

A *super-proportional* reducer is one that reacts more vigorously on the parts of the negative where the silver is the densest than where it is the thinnest, hence the high-lights will be reduced while the shadows will not be acted on. The only known compound which will act as a super-proportional reducer is ammonium persulphate ($(NH_4)_2S_2O_8$); it is a very vigorous oxidizer and when it

combines with the silver of the negative, silver sulphate is formed and this dissolves in the reducing bath.

The subtractive reducer is named after its inventor Howard Farmer, and it is also called a *ferricyanide-hypo reducer,* and it is one that is largely used at the present time:

FORMULA FOR A SUBTRACTIVE REDUCER

Solution A

Hypo (10% solution)	1 ounce

Solution B

Potassium ferricyanide (10% solution)	1 ounce

To reduce a negative add the *Solution A* to *4* ounces of water and then put in just enough of the *Solution B* (a few drops) to make it lemon-colored. Let the negative remain in the reducer for from *1* to *5* minutes, depending on the amount of reduction that is needed. If at the end of *5* minutes it is not sufficiently reduced immerse it in a fresh solution.

The formula for a proportional reducer was devised by Huse and Ninetz and it has the characteristics of both the subtractive reducer described above and the superproportional reducer which will be described presently:

FORMULA FOR A PROPORTIONAL OR TRUE-SCALE REDUCER

Solution A

Potassium permanganate	4⅒ grains
Sulphuric acid (10% solution)	262 minims
Water to make	35 ounces

Solution B

Ammonium persulphate	420 grains
Water to make	35 ounces

When you want to reduce a negative mix *1* part of *Solution A* with *3* parts of *Solution B*. Let the negative remain in the solution from *1* to *3* minutes and then immerse it in a *1* per cent solution of potassium metabisulphite.

A. and L. Lumière originated the following type of reducer and evolved what is known as the *front and back theory*[5] of its reac-

[5] *Bulletin Société Française Photographique,* 1908, p. 395; 1899, p. 226; 1899, p. 399.

tion. This was opposed by other workers including Lüppo-Cramer who advocated the *dispersoid theory*,[6] and Schuller who worked out the *catalytic theory*.[7] You will find these explained in detail in the papers cited in the accompanying footnotes:

FORMULA FOR A SUPERPROPORTIONAL REDUCER

Ammonium persulphate	4 grains
Sulphuric acid (C. P.)*	1 minim
Water to make	1 ounce

* Abbreviation for *chemically pure*.

Use distilled water only and make up the reducer just before you use it. Watch the plate or film carefully as soon as you have placed it in the reducer, and take it out a little before it is fully reduced; now put it in a 5 per cent solution of sodium sulphate. While you do not need to fix it again it is a good scheme to do so as it can then be treated again if you should want to do so.

Kinds of Intensifiers.—In photographic parlance the word *intensification* is used as the reciprocal of *reduction* and, it follows, it means that a thin negative, or one which is lacking in contrast, is made more dense. By the same token an *intensifier* is a compound that will increase the density of an image on a plate or film, and this it does by either (*a*) producing an additional deposit on the negative or (*b*) by making the original deposit more opaque. There are three chief kinds of intensifier compounds and these are (*1*) mercuric chloride, (*2*) mono-ethyl para-aminophenol sulphate, and (*3*) potassium bichromate.

Where a mercuric chloride ($HgCl_2$) solution is used as an intensifier and a negative is immersed in it, it combines with the silver and forms mercuric chloride and silver chloride. The image then becomes white and to intensify it it can be either (*a*) treated with ammonia, or (*b*) developed. If the negative is immersed in a solution of ammonium hydroxide (NH_4OH), *ammonium hydrate*, or just *ammonia* for short, and water, black ammonium chloride will be formed on the silver particles of the image and it will be highly intensified.

[6] "Absorption complexes in the silver grain as the cause of the persulphate effect." *Phot. Korr*, 1908, 45, 159.

[7] "The Theory and Practice of Reduction," *Phot. Rund.*, 1910, 24, 113.

By adding a solution of silver nitrate ($AgNO_3$) to a mono-methyl para-amino-phenol sulphate ($C_6H_4(NH_2)OH.H_2SO_4$) (*Elon*) developer a very good intensifier will result. Now when a thin negative is immersed in this intensifier the silver particles of it are precipitated and these will be deposited on the silver particles that form the image when, it follows, the density of the image will be proportionately increased. The advantages of this intensifier are that (*a*) it does not produce a colored image, and (*b*) it is as permanent as the silver image itself.

A potassium bichromate ($K_2Cr_2O_7$), *chromate of potash,* or just *chromate* for short, has the advantage (*a*) of being easily manipulated, (*b*) certainty of performance, and (*c*) permanence of the intensified image. To intensify a negative with a chromium intensifier it is immersed in a solution of potassium bichromate in which there is a trace of hydrochloric acid. The negative is then developed again when it will be considerably intensified, and by repeating the process a greater intensification can be had. Finally, by varying the time of re-development you can control the degree of intensification.

FORMULA FOR A MERCURIC CHLORIDE INTENSIFIER

Mercuric chloride	476 grains
Hot water	16 ounces
Hydrochloric acid	30 minims

Dissolve the mercuric chloride in the hot water and when it has cooled add the hydrochloric acid. Fix and wash the negative you are going to intensify thoroughly, then place it in the intensifier and when it is completely bleached out wash it thoroughly again. This done immerse it in either:

A. *10* per cent solution of sodium sulphite, or

B. Metol-hydroquinone, Amidol, or a Glycin developer.

Let the negative remain in the solution until it becomes black when it will be greatly intensified.

MONCKHOVEN'S INTENSIFIER

To use this well-known intensifier bleach the negative in the above mecuric chloride solution and then blacken it in the following solution:

Potassium cyanide (pure)	10 grains
Silver nitrate	10 grains
Water	1 ounce

Dissolve the cyanide and the silver separately in *5* ounces of water and add the latter solution to the former until a precipitate is formed. Let the solution stand for *15* minutes and then filter it when it is ready for use. Do not carry the intensification too far or the plate or film may be so greatly acted upon the intensification value may be lost.

What a Desensitizer Is.—A *desensitizer* is an agent which will act on an exposed plate or film and so greatly reduce its sensitiveness that it can be developed in a comparatively bright yellow light without the danger of fogging it; it follows, then, that it makes the development of panchromatic plates and films a simple matter.

The first desensitizing agent was discovered by Lüppo-Cramer, in *1921,* and this is *phenosafranin,* a coal-tar product. This was followed by *pinakryptol, pinakryptol green,* and *pinakryptol yellow* and these compounds, which are also obtained from coal-tar, were found by König, Homolka, and Schüloff.

Basic Scarlet N, another coal-tar dye, was the next desensitizer to be discovered and this was due to the Research Laboratory of the Pathé Cinema, of France, and the latest one is *mercury cyanide* which was patented by the *I. G. Ferbenindustrie* of Germany.

Phenosafranin tends to stain the plate or film while the pinakryptos, which are bright-colored dyes, have no staining action in them, and their desensitizing action is greater than it is with the first-named dye. When pinakryptol is used the time of development is increased, while with pinakryptol green the time of development remains the same.

When either of the last named desensitizers are used to develop a panchromatic plate or film they tend to fog it but by using pinakryptol yellow this untoward action does not take place. Basic Scarlet N and mercury cyanide can also be used without danger of fogging the plate or film.

Any of the following desensitizers except pinakryptol yellow and mercury cyanide can be used either as a preliminary bath or they can be added directly to the developer. If the desensitizer is

used as a preliminary bath the plates or films should remain in the solution for 2 minutes before they are brought into the light and placed in the developer. If it is added to the developer they should remain in it for 3 minutes before the light is turned on.

FORMULA FOR THE PHENOSAFRANIN DESENSITIZER

Phenosafranin	20 grains
Water	8 ounces

FORMULA FOR THE PINAKRYPTOL DESENSITIZER

Pinakryptol	5 grains
Water	10 ounces

FORMULA FOR THE PINAKRYPTOL GREEN DESENSITIZER

Pinakryptol green	5 grains
Water	10 ounces

The above solution is for a preliminary bath. When added to the developer a weaker solution must be used, *i.e.*

Pinakryptol green	1 grain
Water	10 ounces

This desensitizer should be used with either a pyro, glycin, or a metol developer, but not with a hydroquinone one as it tends to precipitate it.

FORMULA FOR THE PINAKRYPTOL YELLOW DESENSITIZER

Pinakryptol yellow	5 grains
Water	10 ounces

This desensitizer must be used as a preliminary bath as its power is neutralized by the sodium sulphite when it is added to the developer. After the plate or film has been immersed in the desensitizer it must then be put in a bath of pinakryptol green.

FORMULA FOR THE BASIC SCARLET N DESENSITIZER

Basic Scarlet N	5 grains
Water	10 ounces

This desensitizer can be used either as a preliminary bath or by adding it to the developer.

FORMULA FOR THE MERCURIC CYANIDE DESENSITIZER

Mercuric cyanide	2.3 grains
Water	16 ounces

This desensitizer cannot be used as a preliminary bath and it cannot be used in a pyro developer, while in all of the others it is slowly precipitated. It is, however, a powerful desensitizer and does not tend to fog the plate or film.

CHAPTER XX

HOW TO DEVELOP AND FIX PLATES AND FILMS

KNOWING now how developers and fixing solutions are made and how they act on the emulsion of an exposed plate or film, you are ready to go ahead with the actual operations of developing and fixing them. Now the two chief things that are necessary to perform these operations with are namely (*1*) the method or process that you must employ, and (*2*) the equipment you must have to perform them with.

The Methods of Development.—*The Visual Method.*—This method of developing a plate or a cut film consists of immersing it in a tray that contains the developer and then rocking it to and fro in a darkroom that is lighted with a *safelight* [1] until the image is dense enough and has sufficient contrast, or *gamma*,[2] as it is called, to make a good print, and to know when this stage has been reached you have to take it out of the tray occasionally after the image has appeared and look at it by the transmitted safelight of your lamp. This method is still in use by many of the old-timers [3] and considering that the exposures and the action of developers on the plate or film are based only on their past experience the results they produce are little short of marvelous.

The Factoral Method.—This is a scientific method of development that was devised by Arthur Watkins, of England, in *1893*, who found that a definite relation existed between (*a*) the time

[1] This is a darkroom lamp with its filter which enables a sensitive material to be seen and manipulated without fogging it.

[2] *Gamma* is the third letter of the Greek alphabet, and in photography it is the numerical expression given to the exact measurement of the steepness of gradation. Thus the average *portrait negative* has a gamma of about *.7*; *landscape and commercial* subjects between *.9* and *.10*. There is quite a variation in personal preference and the printing process must also be considered.

[3] While regular and orthochromatic plates or films can be developed by this method, panchromatic plates or films must be developed in absolute darkness and, hence, the *time and temperature* method must be employed.

of exposure, (*b*) the strength of the developer, (*c*) the temperature of it, and (*d*) the time required to produce a given stage of contrast or value of gamma. He also worked out an algebraic formula for the ratio between these factors and this is called the *development factor* or *Watkins factor.*

When this method first came into use the development factor had to be found by calculation for each different set of conditions, and then Watkins got up what he called a *factorial calculator.* This was a little device which showed at a glance the exact time that the development must be carried on and, it follows, this made it an easily worked and accurate method of developing. The calculator consisted of a pair of rotatable disks pivoted together, the upper one indicating the time of appearance of the image and the lower one the time of development.

The Time and Temperature Method.—This method was worked out by Hunter and Driffield, of England, in *1892*, and it was improved upon by Watkins in *1893;* the advantage of it over the latter's factoral method was that it could be used without having to determine the development factor either mentally or by means of a calculator. This method, which is the one that is now in general use, includes three factors, and these are (*1*) the developing speed of the plate or film, (*2*) the strength of the developer, and (*3*) the temperature effect on the rate of development.

Now with this method all the different makes and brands of plates and films are divided into eight classes, and named these are *very very quick; very quick; quick; medium quick; medium; medium slow; slow,* and *very slow;* these are abbreviated by the letters *VVQ; VQ; Q; MQ; M; MS; S;* and *VS.* These designations *do not* refer to the speed of the exposure of the plate or film but to the time required to reach the proper contrast or gamma when it is being developed.

Further, any one of six different developers can be used whose strength has been computed for this method and these are the (*a*) pyro-soda, (*b*) metol-quinone, for which I gave the formulas in the preceding chapter, and (*c*) Rodinal, (*d*) Azol, (*e*) Citol, and (*f*) Certinol, which are foreign developers. Now instead of changing the time of development of the plates or films of the different classes the strength of the developer is varied and, hence,

at a temperature of 66° F., the same time is taken for the development of a plate or film of whatever class.

How to Use the Method.—All you have to do to use this method is to know what the developing speed of the plate or film is and to find out this, as well as the other necessary factors you can get a printed chart which shows their relation to the time of development from any photographic supply house or from the manufacturer of the plate or film you are using.

Having chosen the developer you want to use from those I have given in the preceding chapter, and mixed it carefully to the proper strength and heated or cooled it to the proper temperature, *i.e.*, 66° F., you put it in the tray or tank and immerse the plate or film in it, and this must, of course, be done either in a safelight or in total darkness depending on the kind of plates or films you are developing. If you use a *tray* and are developing a plate or a cut film lay it with the emulsion-coated side up, and pour the developer from your glass graduate over it so that all parts of it will be covered and air bubbles will not be formed on it, and then gently rock the tray until it is developed. Should you use a *tank*, place the plate or film in the rack or on the reel and let this down into the developer.

Whichever way you do it the moment you have immersed the plate or film in the developer start your timer, or lacking one you can use an ordinary clock or watch. Since with this method you do not need to lift the plate out of the developer in order to see how the image on it is progressing you can put a cover on the tray or tank and then turn on the white light lamp in order to keep your eye on the timepiece. When the time of development is up you turn off the white light and take out the plate or film, when it is ready to be fixed.

If you prefer you can *desensitize* the plate or film by immersing it in a *desensitizing bath*[4] or you can add the desensitizer to the developer. In either case the plate or film must be left in the bath or the developer for a couple of minutes either in a safelight or in total darkness. After this time has elapsed it can then be developed in a bright yellow or orange light, and this makes the operation of development considerably easier.

[4] You will find a formula for this in the preceding chapter.

The Method of Fixation.—After you have developed the plate or film rinse it off in water and immerse it in the *fixing bath*. To fix a plate or film so that it will not fade out in the course of time it must be left in the fixing bath until the sodium thiosulphate, or *hypo*, which is the fixing agent, has dissolved out the unchanged silver bromide there is in it. The old way—and it is still a good one—to tell when a plate or a film is properly fixed is to leave it in the bath until the milky-white coating disappears from the back of it, and then let it remain in the bath for the same length of time that it took for the coating to disappear.

When enough plates or films have been fixed so that the bath contains 2 per cent of silver it is said to be *exhausted*, because it will no longer dissolve out all of the unaltered silver bromide from them no matter how long they are allowed to remain in it. For this reason it is a good scheme, though seldom done, to use two fixing baths, and then fix the plate or film in the older one first and when the milky coating disappears take it out, wash it off and put it in the fresh one for 5 minutes or so when it will be thoroughly fixed.

How to Wash the Negatives.—After the negative is fixed it must be thoroughly washed in water to remove the hypo and free silver salts from the gelatin coating, for if these compounds are not eliminated they will form crystals in the gelatin and break it up. The best way to wash negatives is to use running water, but if this is lacking you can wash them by changing it.

If you use running water you can let it run directly on the negative, or if you have a number of them you can set them in a rack if they are glass ones, or suspend them by clips if they are films and then place them in a tank and let a stream of water flow through it for 30 minutes or so. If running water is not at hand lay the negatives in a large tray, fill it with water, let them remain in it for 5 minutes or so, then change the water and repeat this operation 10 or 12 times when they will be fairly well washed.

How to Dry Negatives.—After you have washed the negatives the final step is to gently wipe off the surface of each one with a wad of absorbent cotton or a viscose silk sponge in order to remove any dust or other particles that may have come in contact with the coating. This done set the negatives, if they are

glass ones, in the grooves of a drying rack, or if they are films hang them on a line with clips. In either case place them where a current of fresh air will pass over them and it must be free from particles of dust. Negatives of either kind should easily dry overnight and they should never take longer than *24* hours.

How to Quickly Dry a Negative.—You may often find it necessary to make a print from a negative as soon as it has been fixed and washed, as for example, if you are doing press work, and, it follows, it must be dried quickly. To do this you can make up a *formalin drying solution* as follows:[5]

FORMULA FOR THE DRYING BATH

Formalin	1 part
Water	50 parts

To dry the negative quickly rinse it off as soon as you have developed it, then immerse it in the above bath for *10* minutes, wash it off by pouring nearly boiling water over it, heat it gently for a minute or two when it will dry quickly and you can make a print of it.

The Equipment You Need.—To develop, wash, and dry plates or films you will need various things and chief among these are (*1*) a darkroom, (*2*) a safelight, (*3*) a couple of glass graduates, (*4*) a stirring rod, (*5*) a thermometer, (*6*) a timer, (*7*) developing, fixing and washing trays or tanks, and (*8*) a negative dryer.

About Your Darkroom.—The darkroom is, as you probably well know, a room in which you can perform the operations of changing plates and films in the camera, developing, fixing and often, but by no means necessarily, washing them. To perform these operations, the darkroom, as its name indicates must be, (*1*) perfectly light-tight, *i.e.*, so that it will totally exclude all light rays from the outside of it, (*2*) it should have running water, (*3*) be adequately ventilated, (*4*) have white lights, (*5*) one or

[5] *Formalin* is a *40* per cent aqueous solution of formaldehyde (*H.CHO*) and this is a sharp, penetrating gas that is formed by the partial combustion of methyl alcohol, and it can be made in other ways. It possesses the property of hardening the wet coating of a negative so that it will not melt when it is heated.

more safelights, and, (6) be fitted with a bench, a cabinet and one or more drawers.

Where you have a roomy house or an apartment, and are not pinched for the wherewithal it is easy to fit up a darkroom with every possible convenience like the one that my friend, Lee Parsons Davis, of New Rochelle, New York, has. But for the amateur who has a limited amount of space and a still more limited exchequer, the question of a darkroom often presents a real problem.

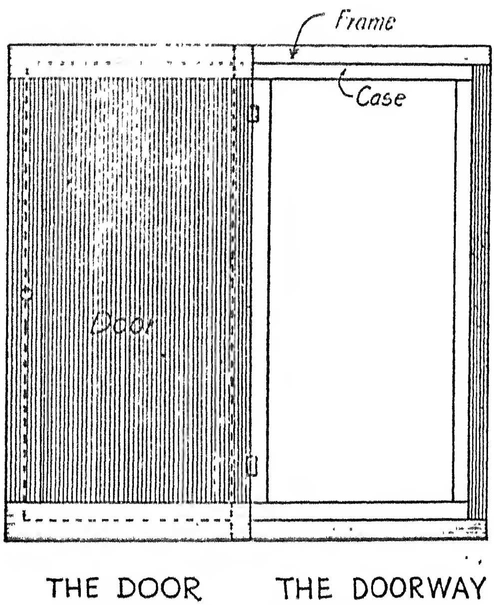


Fig. 108.—A Light-Tight Door

Now there are several makeshifts that you can use in lieu of a conventionally planned darkroom and chief among these are (*a*) the attic, (*b*) the basement, (*c*) a closet, (*d*) the bathroom, (*e*) the kitchen, (*f*) the garage, and, lastly, (*g*) you can make a portable one.

Where an attic, a basement, or a garage is available all you need to do is to partition off a space about 6 feet wide, 7 feet long and 7 feet high and a good material to make this of is pine or 3-ply

boards. The darkroom thus improvised must, of course, have a door that is light-tight when it is shut, and the joints must be carefully made or sealed up so that when the door is closed not a vestige of light can get into it. The way to make a light-tight door is shown in *Fig. 108*.

The Water Supply.—Where you improvise a darkroom in an attic, a basement, or a garage it usually costs quite a little to pipe